

Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review

Final Report Appendices

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&

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APPENDIX 1

Waste Reduction Experience in Other Jurisdictions

Detailed Review

Resource Productivity Improvements

Overview

Numerous programs in jurisdictions throughout the U.S. and abroad are aimed at improving resource productivity (also called eco-efficiency) from manufacturers and business service providers. These include:

- Pollution Prevention (P2)
- Lean Manufacturing
- Green Permitting
- Light-weighting
- Industrial Ecology
- Technological Advances
 - Miniaturization and Dematerialization
 - Micro- and Nano-Technology

These efforts are all aimed at impacting private sector behavior through education, technical assistance, incentives, and/or regulation, and have considerable overlap with the subsequent sections of this report. In this section, therefore, we describe only a few programs related to resource productivity improvements.

In addition to the direct benefits of utilizing less material and energy per unit of output, these practices also produce indirect benefits by reducing the related “external” costs of pollution that result in environmental degradation and public health impacts. While these costs are generally not reflected in the price of such goods or services (see section 5 on economic incentives), their reduction is an important societal benefit.

Program Descriptions

California Integrated Waste Management Board

In November 2001, the CIWMB adopted a Strategic Plan highlighting: sustainability, product stewardship, energy recovery, environmental justice, safe disposal of waste, and the promotion of a zero-waste philosophy. Zero-waste strives to maximize waste reduction and use the most effective processing or manufacturing practices to optimize efficiency and conserve natural resources. It promotes both front-end (e.g., waste prevention and reuse) and back-end (e.g., recycling) methods as well as using waste to generate energy. Obviously, it is the Board’s front-end reduction efforts that are most relevant to MA DEP’s efforts.

Part of CIWMB's strategy is to promote best business practices in product manufacturing and handling by:

- Partnering with other State agencies to create cross-media approaches to working with business to assist in achieving zero waste.
- Partnering with trade associations to promote cost-beneficial source reduction and related manufacturing improvement opportunities (through improved technologies, packaging efficiencies, best business practices, etc.).
- Creating model programs that are self-sustaining and transferable to others.
- Evaluating long-term benefits of pilot programs or models.

CIWMB's efforts have resulted in significant waste prevention and diversion reduced amounts disposal since 1989, as measured by the Board's disposal reporting system. While the Board's work that has contributed to waste prevention has focused on a variety of programs and waste streams—edible food rescue, organics diversion, California Materials Exchange (CalMAX), Waste Reduction Awards Program (WRAP), and green building—CIWMB's **packaging redesign** efforts are most relevant in terms of this section of the report on improving resource productivity. The idea of efficient packaging and waste reduction in packaging in California began with the Shipping and Distribution Partnership, a voluntary effort created to encourage businesses to adopt more efficient packaging and distribution systems that save money while preventing waste and improving operations. As elsewhere, packaging related waste comprises approximately one third of the state's solid waste.

In addition to direct elimination or reduction of packaging, the Board promotes designing refillable or reusable packages, and producing recyclable packages and packages made of recyclable material. CIWMB's packaging redesign initiative focuses on preventing or reusing (or recycling) five key materials:

- Composites
- Paper
- Plastic
- Steel/Metal
- Wood

MN Pollution Control Agency

The MN PCA's Pollution Prevention and Sustainability Program comprises an agency-wide staff effort to utilize regulatory flexibility as an incentive for businesses to pursue pollution prevention and waste reduction. The program's goals are to reduce the use of toxics and encourage the reuse of materials by promoting long-term process improvements and the adoption of best management practices for waste reduction.

Program efforts to date have focused principally on toxics prevention. Key program elements include:

- Waste reduction/reuse
- Regulatory innovation
- Deconstruction
- Product responsibility/stewardship
- Design for the environment

Note that these elements of MN PCA Pollution Prevention and Sustainability Program span several of the strategy categories in this report, including Regulatory Requirements. It is described here because its major thrust is to increase resource productivity.

Challenges

Among the most significant challenges facing governments attempting to encourage resource productivity improvements in the manufacturing and service sectors are: the inertia of existing production systems and the significant costs to companies of modifying them; a lack of awareness and/or willingness among businesses to alter existing practices; the fact that long-term environmental and health consequences of product life-cycles are not reflected in their price; the reliance on voluntary programs where regulatory authority does not exist or does not enjoy adequate political support; dematerialization technologies (e.g., micro- and nano-technology) that have not yet been proven or commercialized; and a lack consumer education and demand for products and services that generate less waste. Many of these challenges relate to and are further discussed in the other sections of this report.

Assessment

There is a vast array of existing and emerging public sector programs aimed at encouraging and facilitating resource productivity improvements throughout the manufacturing and service sectors. Experience with some of these—pollution prevention and light-weighting, for example—have already proven to be effective in preventing waste, while other emerging approaches such as industrial ecology and dematerialization through micro- and nano-technology, hold enormous promise but the potential role for government efforts remains unclear and deserves further attention. Initiatives to promote product stewardship, Design for Environment (DfE) approaches, and purchasing of environmentally preferable products (EPP), described in later sections, will also result in resource productivity improvements.

Alternative Business Models

Overview

Over the past quarter of a century businesses in the U.S. and around the world have become increasingly concerned with the environmental impacts of their products and services. Driven by a combination of factors—more stringent environmental regulations, growing demand for “green” products among consumers, and a recognition that preventing waste and pollution can save money and improve a company’s image—new business models have emerged that reduce waste and prevent toxic pollution. These alternative models include:

Design for Environment (DfE)

There are three main approaches governments take to promote DfE in industry: (1) voluntary programs where agencies provide information and possibly technical assistance or procurement preferences; (2) regulatory requirements in which mandatory take-back provisions or material bans are imposed; or (3) a combination of these.¹ The best way to measure the effectiveness of DfE initiatives would be to track product design changes in industry. Unfortunately, it is difficult to sort out the many causal factors that often accompany product design changes, and there are few documented examples of specific product changes clearly attributable to DfE efforts. Note that most DfE programs focus on reducing or eliminating toxic materials as opposed to preventing solid waste.

Supply Chain Management

Supply chain management approaches recognize that waste prevention and other environmental improvements can often be most efficiently implemented if the whole product chain, or system, is involved. Supply chain management addresses the performance of materials, components, and goods and services that an organization buys and uses. Ideally, supply chain management identifies the most significant waste prevention opportunities by considering the entire product system and working cooperatively with suppliers to prevent such waste. This often involves the use of life-cycle assessment (LCA) tools. There are three dimensions to environmental supply chain management: (1) the supply chain through a network of upstream and downstream linkages; (2) the environmental impacts of materials and energy inputs and outputs; and (3) the management of the business organization.

Product Stewardship

Product stewardship is a product-centered approach to waste prevention and environmental protection. Also known as extended product responsibility (EPR), product stewardship requires those in the product life cycle—manufacturers, retailers, users, and

¹ Given the important role of government regulation in promoting Design for Environment efforts in the business sector, many of the DfE programs are closely related to the programs described under Regulatory Requirements.

disposers—to share responsibility for reducing the environmental impacts of products. As such product stewardship is distinct from and goes beyond manufacturer-centered extended *producer* responsibility approaches. It recognizes that waste reduction and other environmental improvements will be enhanced by going beyond producers acting alone, to include retailers, consumers, and the existing waste management infrastructure. Note that product stewardship approaches and the key stakeholders will vary from one product system to another. Note that in the program descriptions that follow, we have not included EPR, as these programs are described in section 6, Regulatory Requirements.

Leasing and “Servicizing”

Servicizing refers to selling a service or function rather than a product, and can include operating leases and trade-ins. Actual ownership of the product remains with the supplier, and customers generally pay for use and maintenance of the product. Servicizing can therefore be thought of as very closely related to or a type of extended product responsibility. Some servicing examples include carpet leasing, office equipment leasing, outsourcing of onsite chemical management, and office furniture supply and maintenance.

Potential customer benefits include:

- Environmental and cost savings without much effort on customer's behalf.
- Allows customer to focus on their primary areas of business.
- Maintenance and ultimate disposal is the supplier's responsibility.
- Product(s) are managed by the supplier, who best knows the product, liabilities, and waste reduction opportunities.
- Optional shared savings incentivizes both customer and supplier to reduce and recycle. Proving your products meet certain codes or policy is a good way to establish market niche.

In servicing relationships, the vendor may function as much as a partner, problem-solver, and information resource as the product provider. Servicizing has inherent incentives to maximize and recapture the end-of-life value of products and equipment.

Program Descriptions

Design for Environment (DfE) Programs

- **The European Union’s Restrictions on Hazardous Substances (RoHS) Directive** is perhaps the most far-reaching regulatory approaches to DfE to date. It requires manufacturers to replace mercury, lead, hexavalent chromium, and other heavy metals in a variety of products, including:
 - *Large household appliances:* refrigerators, washers, stoves, air conditioners

- *Small household appliances: vacuum cleaners, hair dryers, coffee makers, irons*
- *Computing & communications equipment: computers, printers, copiers, phones*
- *Consumer electronics: TVs, DVD players, stereos, video cameras*
- *Lighting: lamps, lighting fixtures, light bulbs*
- *Power tools: drills, saws, nail guns, sprayers, lathes, trimmers, blowers*
- *Toys and sports equipment: videogames, electric trains, treadmills*
- *Automatic dispensers: vending machines, ATM machines*

The following products are currently exempted from RoHS compliance:

- Large stationary industrial tools
- Control and monitoring equipment
- National security use and military equipment
- Medical devices
- Some light bulbs and some batteries
- Spare parts for electronic equipment in the market before July 1, 2006.

Other countries that are working on their own version of RoHS:

- **RPCEP (Regulation for Pollution Control of Electronic Products):**
China
Effective July 1, 2006
- **GPSSI (Japan Green Procurement Survey Standardization Initiative):**
Japan
Effective July 1, 2006
- **SB20 (Electronic Waste Recycling Act of 2003):** California, USA
Goes into effect January 1, 2007
- **Adopting the EU RoHs Directive:** Australia, Canada, Korea, Taiwan
- **EU's Waste Electronic and Electrical Equipment (WEEE) Directive** mandates aggressive reuse and recycling targets of 65-75% for certain products. Producers must comply with these requirements if they want to sell their products in Europe. WEEE Directive 2002/96/EC mandates the treatment, recovery and recycling of electric and electronic equipment (prior to the WEEE Directive, 90% was landfilled). All applicable products in the EU market since August 13, 2006 must pass WEEE compliance and carry the "Wheelie Bin" sticker.
- In the packaging arena, **Germany's mandatory Packaging Ordinance** and the associated Green Dot Program has resulted in design changes for beverage

packaging in Germany and elsewhere in Europe. On the voluntary side, the U.S. EPA's DfE Program and the UK's Waste Minimization and Resources Action Programme (WRAP) cite design changes by manufacturers.

Supply Chain Management

Most government efforts on supply chain management have focused on educating and providing technical assistance to private sector businesses. Trainings have been organized at the state and regional level, often with support from U.S. EPA. In addition, many government bodies, at all levels, are directly influencing their suppliers through environmental requirements, primarily through green procurement programs. In many states (including MA, as well as MN, NY, WA) these programs have expanded greatly in recent years from an initial focus on office supplies and equipment to virtually all goods and services a state requires.

Challenges

Product stewardship/EPR initiatives as well as Design for Environment programs based on a mandatory approach are challenged by the same political obstacles that many other regulatory programs face in building support among diverse interests. Managing supply chain issues is extremely complex and there are a number of issues that will affect the growth of supply chain management as a tool for meeting business objectives and improving environmental performance. Companies often have diverse suppliers that can range from multinationals to small and medium size enterprises. Another challenge is designing adequate incentives (internally and externally) and insuring that waste prevention and other environmental requirements are met and that data is reliable. Overcoming these and other issues will affect the extent to which supply chain management approaches are used in the future. The emerging servicizing model is still relatively new and unfamiliar to many producers and consumers, and requires both additional analytical work on the costs and benefits to producers and consumers, as well as considerable public education.

Assessment

It is important to note that the degree to which DfE approaches are relevant varies by product type, with packaging, electronics, beverage container, carpet, and vehicles already showing considerable promise in various jurisdictions, both in Europe and the U.S. The range of DfE experience indicates that incentives are key for getting manufacturers to redesign their products to reduce waste, toxicity, or other environmental impacts. These incentives can be in the form of take-back requirements or material bans on the regulatory side, or through preferential tax treatment, public procurement, and/or financial or technical support. Experience in Europe and elsewhere has shown that if producers are required to bear the full cost of managing their discarded products they will have a direct incentive to account for such costs in their decisions about product design and marketing. For example, Germany's mandatory Packaging Ordinance and the associated Green Dot Program have resulted in design changes for beverage packaging in

Germany and elsewhere in Europe. On the voluntary side, the U.S. EPA's DfE Program and the UK's Waste Minimization and Resources Action Programme (WRAP) cite design changes by manufacturers.

Many government bodies, at all levels, are influencing their suppliers through environmental requirements, primarily through green procurement programs. Expansion and additional promotion of environmental purchasing activities and tools can further this effort. In addition, there is a role for technical assistance and incentives for small business to apply greening-the-supply-chain techniques, as individually they often lack the buying power and resources to influence suppliers. To the extent possible, standardizing environmental purchasing criteria (a la Energy Star) beyond an individual municipality or even state would ease the burden on manufacturers and suppliers for meeting such criteria.

To date public policy has played little role in promoting servicizing. There are however, a number of possible government policy initiatives that could help realize the potential environmental gains associated with product-based services. Policies that incorporate the social costs of materials extraction and disposal into the purchase price of products are likely to have two effects: (1) building further market demand for decoupling ownership from product use; and (2) building demand for lifecycle management as an explicit component of service offerings. Such policies include, for example: removal of virgin material and disposal subsidies, or tax policy which favors producer, not customer, ownership of durable goods. Government can also play an important role as convener and facilitator of stakeholder processes to explore these and additional policy initiatives and forms of technical assistance. While EPR/servicizing policies have received their share of criticism, they have focused the attention of businesses on providing environmentally beneficial end-of-life services.

Public Education and Awareness

Overview

Education and awareness-building activities are intrinsically tied to and reinforce the other waste prevention and reuse strategy elements. Increased concern by policymakers and the public over local and global environmental impacts of consumption is reflected in a host of public education and action campaigns to address the demand side of the equation. These efforts go well beyond the common practice of informing citizens about the benefits of household practices such as grasscycling and backyard composting, to far-reaching initiatives that promote sustainable consumption opportunities by consumers and communities. Such efforts focus on building consumer demand for more environmentally friendly or preferable products and growing the “sustainable lifestyle” movement (including the simplicity movement). Techniques include the full range of media, from radio and television including public service announcements, to newspapers and other printed materials including transit posters and bill stuffers, to the internet. Techniques such as Community-based social marketing (CBSM),² which MA DEP has employed on a limited basis, have emerged as particularly effective ways for reaching and educating targeted audiences and encouraging specific behavior change towards waste prevention and other goals.

Several jurisdictions in the U.S. have strong demand-side programs built around public education and awareness. In the following section particular emphasis is given to programs related to education and promotion of green building practices, an important focus of waste prevention efforts. In addition, the European Union and its members are world leaders in the sustainable consumption arena. Their experience is highlighted later in this section.

Program Descriptions

Washington State Beyond Waste Program

Washington’s Beyond Waste Program explicitly takes on “the substantial task of redefining American consumerism and culture.” It views waste as inefficient resource use, and adopts a materials flow framework to help identify, evaluate and prioritize activities and sectors that produce significant waste flows in terms of volume and/or toxicity. The program aims to minimize material and waste flows through efficient use of resources, recovering material for high-value reuse, and incorporating “cradle-to-cradle” design. The Beyond Waste Program has established long-term (30-year) goals and five-year milestones, and has identified 64 specific actions to move Washington towards this vision. Three broad strategies have focused on:

² Community-based social marketing comprises five steps: selecting behaviors, identifying barriers, developing strategies, conducting a pilot, and broad scale implementation. It is used primarily to try and change environmentally-harmful behaviors among residents and businesses.

- **Making green building practices mainstream.** Goals include increasing awareness, knowledge and access to green building resources, developing and implementing incentives for green design and construction and removing disincentives, and maximizing reuse and recycling of construction and demolition (C&D) materials. The plan calls for the following specific actions:
 - Adopt LEED standards for all new state buildings
 - Make residential Built GreenTM program available to all residents
 - Technical assistance to builders re: LEED and Built GreenTM programs
 - State procurement guidelines should require green building materials
 - Support deconstruction industry through grants, pilots, training
 - Work with local governments to ensure adequate C&D processing capacity (especially for concrete, gypsum, wood)
 - Intensify work with national partners on building material product stewardship
 - Educate architects and contractors about designing buildings for less waste and deconstruction
- **Establishing an organics recovery cycle.** Actions include increasing the residential and commercial organics recovery programs and resolving statutory and regulatory barriers.
- **Reducing hazardous waste in the industrial sector.** Actions include sector focused reduction plans (mercury, PBDE), providing incentives to businesses to adopt sustainability practices, and encouraging waste haulers to become materials brokers.

King County, Washington

King County has an expansive public education around waste prevention, including:

- **Green Building Program**
 Provides tools and assistance to promote high recycling and reuse rates. Examples of tools include jobsite waste guidelines, a waste management template, sample waste recycling specifications, a directory of local construction waste recyclers. Assistance includes presentations to jobsite workers, site visits and assessments, and research about recycling and reuse options.
 - Prevent Jobsite Waste
 - Design Specifications & Waste Management Plans (includes examples of design specifications that use specific language to address expectations for waste reduction)
 - Construction, Demolition, and Land-clearing Debris Recycling

- **EcoConsumer (Gateway Program)**
 - Promotes conscientious purchasing choices
 - EcoConsumer TV Ads; Featured Resources for TV Ads
 - EcoConsumer Columns in *The Seattle Times*
 - Other public outreach (radio interviews and public presentations)
 - Waste Calculator (similar to eco-footprint calculator)
 - Links (to directories, guides, household tips and green lifestyle advice)
- **Waste Prevention Resources**
 - Waste prevention tips and information on reducing junk mail, and the National Waste Prevention Coalition (including Waste Prevention Forum)
 - Waste free holidays (business partners)
 - Northwest Yard Days
 - EcoDeals.org (Website featuring high-performance products and services, descriptions, coupons, etc.)

City of Seattle

Seattle has long been known as a leader in waste prevention and reuse.

- **Education and Technical Assistance** - Seattle Public Utilities, the agency responsible for managing the City's solid waste, has a robust education and technical assistance program that promotes home composting, grasscycling, and natural gardening."
- **"Use It Again, Seattle!"** is the City's popular way of keeping reusable items out of the landfill. Residents can drop off their unwanted but reusable items free of charge. Items are first made available to local charity partners. Remaining items are then made available to the public. While until this year Use It Again events were held at the neighborhood level, SPU found this to be expensive and is currently piloting a similar effort at a single location -- one of the City's major recycling and disposal stations.
- The **Resource Venture** initiative provides free educational materials, technical assistance and training to help businesses reduce waste and prevent pollution. It also has a strong green building program with an emphasis on preventing C&D waste.

U.S. Green Building Council – Leadership in Energy and Environmental Design

Through its Leadership in Energy and Environmental Design (LEED) program, the USGBC has been very successful in raising awareness of the benefits of green building. Its successful development and broad dissemination of LEED standards are having a transformative impact in the commercial sector, with thousands of buildings nationwide

pursuing LEED certification, and USGBC is attempting to do the same for housing with the recently released LEED Home Program (Draft). Like its predecessors, LEED Home is a certification program for green homes, with a point system for different levels of green (Certified, Silver, Gold, Platinum).

- LEED Home places considerable emphasis on resource use and recognizes the important driver that house size is:
 - 24 of 108 total points for Materials and Resources use
 - Home size emphasized due to relationship to materials & energy use whereby up to 10 points are awarded for smaller than national average home size and larger than average homes are penalized by point deductions
 - Up to 2 points each for material efficient framing and reduced job-site waste generation
 - Points also available for improving durability of the building envelope, components and systems through appropriate design and materials selection and installation

California Integrated Waste Management Board

CIWMB has an extensive education and technical assistance program and provides residents and businesses with a wide range of materials to promote waste reduction and reuse. The elements of the Board's program include educational materials concerning:

- Business Waste Reduction Resources Index
- Beyond Waste Prevention
- Construction and Demolition
- Environmentally Preferable Purchasing—Green Lodging
- Organics (biosolids, food scrap management, home gardening, grasscycling, greenscaping, sustainable commercial landscaping, etc.)
- Packaging
- Paper Reduction Information Resources
- Reuse
- Waste Prevention Information Exchange (very extensive on-line directory of informational resources organized by prevention and reuse topic)

Alameda County, CA

Alameda County's Business Assistance Program is designed to prevent waste, boost resource efficiency and materials recovery, and enhance markets for recyclables. The program targets businesses, public agencies and institutions and includes commercial, industrial and office environments. The program includes:

- Comprehensive environmental assessments and financial (grants) and technical assistance to implement waste prevention practices.
- Marketing campaign to prevent transport marketing waste, through promoting reusable shipping containers and other methods.

In addition, the Alameda County Organics Program provides educational workshops and tours, (Bay-Friendly Gardening), and coordination with the Master Composter project and the Compost and Worm Bin Distribution program to support on-site composting and waste prevention. Achievements include the diversion of over 16,000 tons of material from residential programs and 22,000 tons from commercial programs in 2004 (includes on-site and centralized composting). Program has maintained a 20% participation rate for compost bin sales.

Challenges

Several important challenges face public education and awareness campaigns for waste prevention and reuse. There is a general reluctance on the part of businesses and citizens to modify existing practices until they are forced to do so, either through regulation or in response to a perceived crisis. Moreover, businesses and citizens are bombarded with messages and advice on an ongoing basis. It is difficult to make waste prevention and reuse rise above the myriad of other issues facing society. Educational messages therefore need to strike a balance between urgency based on the negative consequences of inaction, and the positive implications for citizens, businesses, and society generally of implementing prevention activities.

Specific educational efforts may not be well coordinated with other elements and a broader waste prevention and reuse strategy, thereby weakening their effectiveness. If not part of an integrated strategy with clear priorities, awareness campaigns may not identify the most important specific actions that citizens and businesses should implement to achieve waste prevention. Since waste prevention results from a combination of many factors, it is difficult to measure or even estimate the impact of educational initiatives. Community-based social marketing techniques have begun to introduce the importance of measuring the impact of educational programs, but evaluating effectiveness remains an important challenge. This lack of evaluation data leads to a final hurdle, that of obtaining adequate resources to maintain educational programs.

Assessment

Waste prevention and reuse educational efforts vary widely across jurisdictions in the U.S. and abroad, ranging from general public service announcements with vague pronouncements about using resources wisely to specific initiatives with explicit guidance on why and how to reduce particular wastes. All programs are built on the premise that public education and awareness are essential elements for successful waste prevention. Of course, the success of these programs, wherever they are located, depends partly on an adequate ongoing level of funding.

The most effective programs, such as King County and Washington State, appear to be those that: (a) are well integrated into a larger strategy; (b) identify clear priorities; (c) are linked to quantitative and achievable waste reduction targets or goals, especially if these were developed through an inclusive stakeholder process; (d) include a tracking mechanism to measure success; and (e) relate to or are motivated by regulatory requirements. The recent popularity of education programs aimed at promoting green building is not surprising, as they meet most if not all of these criteria.

Note that in terms of placing the waste prevention education initiative within a larger strategy, where appropriate MA DEP should look for opportunities to link the effort with “hot” issues that have gained public attention, such as climate change or increasing energy prices.

Economic Incentives

Overview

Economic instruments are a powerful tool for promoting waste prevention and reuse, both through taxing wasteful practices and by positive financial incentives for preferred practices. “Environmental taxes,” as they are sometimes referred to, can take the form of point-of-sale levies, pre-disposal fees, packaging taxes, as well as alternative pricing or contracting arrangements for waste management. Positive incentives may include tax credits for capital investments in waste prevention technologies or processes, or direct support or subsidy for adoption of such technologies and/or practices.

Two key programs aimed at preventing waste by altering the way waste management services are provided and paid for are Pay-As-You-Throw (PAYT) or Variable Rate systems, and Resource Management (RM) Contracting, primarily aimed at the business sector. While these approaches are initially aimed downstream at the waste produced, ultimately they promote waste reduction and reuse.

Pay-As-You-Throw (PAYT)

As the name implies, PAYT changes the way in which garbage collection and disposal services are priced. Rather than the traditional fixed bill for unlimited collection, PAYT systems set their charges based on the amount of waste disposed (usually per bag or can, sometimes by weight). This approach mirrors how we pay for other utilities such as electricity, gas, and water, and provides waste generators (households or businesses) with an incentive to reduce the amount of waste discarded, either through waste prevention, reuse, or recycling. While most diversion of waste from disposal results from increased recycling rates, a significant fraction (5-10% or more) is related to waste prevention efforts. As described below, over the past two decades PAYT programs have become increasingly popular throughout the country.

Resource Management Contracting

RM contracting addresses an essential and often overlooked approach to waste prevention: the contractual relationships between waste generators and waste management service providers. Contracts are pervasive in the commercial/industrial waste management field and directly influence the way the vast majority of businesses manage their waste. Unlike traditional solid waste service contracts, an RM approach compensates waste contractors based on performance in achieving the organization's waste reduction goals rather than the volume of waste disposed. As a result, RM contracts align the interests of generators and contractors so that they share the financial benefits of cost-effective resource efficiency through prevention, recycling, and recovery.

RM contracting is similar to performance-based contracting that has been used in the energy and the chemical purchasing, use, and management industries for a number of years. Under RM contracting the contractor takes responsibility for managing a company's waste and is paid a set fee, at or below the company's current waste management costs. The contractor adopts the risk for waste management but also gains

financial rewards for making it more efficient. The efficiency gains are shared between the contractor and the business.

RM contracting recognizes that waste management is not part of the core business or expertise of most companies. Through an RM contract, the contractor provides the waste management expertise and has a vested interest in minimizing waste.

Program Descriptions

PAYT

According to a recent inventory of state regulations and policies,³ as of 2001 at least four states mandated some form PAYT or Variable Rate pricing: Iowa, Minnesota, Washington, and Wisconsin, while Oregon includes PAYT as one of the options from a menu of choices communities must select. Thirteen states gave preference in their financial incentives or grants to communities with PAYT systems, and about 33 states actively promote or offer education about PAYT. Leading states where PAYT is most common include: CA, IA, MA, MI, MN, NY, OH, OR, VT, WA, and WI.

Some states (Wisconsin, Oregon and Minnesota) even have a law requiring that communities use PAYT. PAYT is generally most effective in small cities and suburban areas but has not worked as well in densely populated urban areas where apartment dwellers use chutes and dumpsters for their normal disposal. Also, PAYT may not be as well-suited to very rural areas where illicit dump sites are easy to find. In general, it is most feasible where individual households' weekly trash and recycling can be readily measured and monitored.⁴

RM Contracting

To date, U.S. EPA and several states (e.g., Massachusetts, Nebraska, Nevada) have done much to test the effectiveness of RM contracting. U.S. EPA has been promoting Resource Management contracting through its WasteWise Program and website (see <http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/wrr/rm.htm>), which includes an extensive guidance document on “Resource Management: Innovative Solid Waste Contracting Methods.” The agency has also sponsored training of businesses and waste management firms.

MA DEP has also been a leader in promoting RM contracting practices, as it supported pilot project assessing its potential in diverse commercial, industrial and institutional settings. Pilot projects in MA and elsewhere have shown great promise for diverting significant fractions (an additional 15–30%) of the commercial waste stream. Public

³ Skumatz Economic Research Associates, 2001.

⁴ Don Fullerton and Margaret Walls, “Trash Talk, Resources for the Future Weekly Policy Commentary, December 3, 2007. Accessed at: http://www.rff.org/Publications/WPC/Pages/12_03_07_Trash_Talk_Walls_Fullerton.aspx.

sector RM projects in other states have been implemented at the county and school district levels.

While not a state-incentivized program, General Motors' successful implementation of RM contracting in several of its North American plants provides a sense of the potential impact of RM. GM saw dramatic waste reductions, increases in recycling, and cost savings. Raytheon has also recently implemented RM contracting in its Northeast operations and has been monitoring its waste reduction impacts.

Challenges

A key challenge is to help create a sustainable, long-term market for RM services so waste management companies as well as firms with procurement expertise and industrial and commercial operations experience develop RM capabilities and become RM service providers. To accomplish this may require additional resources from DEP to educate and motivate both potential customers and suppliers of RM services. The goal should be to develop and implement a critical mass of RM programs so that customers and RM service providers will perpetuate RM contracting activity without significant further resources from the Department.

Assessment

Over 120 MA municipalities have implemented PAYT programs, though many of the Commonwealth's largest cities have not yet done so. As part of MA DEP's 2006 Revision to Solid Waste Master Plan, the Department continued its longstanding support for Pay-As-You-Throw programs through grants and technical support for municipal PAYT programs. Based on the vast experience in MA communities and other jurisdictions, there may be room to expand PAYT into larger cities and refine implementation strategies to make it even more effective.

Resource Management contracting pilots in Massachusetts and elsewhere show significant waste reduction potential, on the order of 15-30%. RM aligns the interests of businesses and their Resource Management contractors and shifts the incentives towards minimizing waste. RM contracting can be applied across many industrial and commercial sectors

While in the near term RM contractors are likely to continue to come from the waste management and recycling industry and focus primarily on diversion and recycling, the potential exists for transitioning RM contracting into an effective waste prevention strategy. Such a transition will require the RM industry to mature and attract new contractors with expertise in a range of industrial and commercial operations, including procurement, product design, and packaging. Over time, the strategic alliances formed may enable RM contractors to influence upstream decisions related to product design and material choice, use, and handling, not just waste management practices. This upstream focus will be necessary for RM contracting to achieve more significant waste reductions and contribute to the Commonwealth's aggressive waste prevention objectives.

There are strong precedents for this kind of approach in the energy and the chemicals arenas. As a voluntary approach, there should be little opposition from industry, though the waste management industry may be reluctant to embrace a new business model. Moreover, waste management practices and costs generally do not receive much attention from business managers. State educational and training efforts would need to be offered to businesses and potential RM service providers, emphasizing the potential for win-win outcomes. Coupled with other initiatives, RM contracting holds considerable promise as a means to help transform business thinking from a waste management mentality to a waste prevention and materials management approach.

Regulatory Requirements

Overview

A variety of regulatory requirements have been successful in achieving waste prevention targets. Among the most effective initiatives are: extended producer responsibility (EPR) and material or waste bans.⁵ These programs often lead to or are closely linked with the alternative business models, such as Design for Environment or product stewardship, described above. It is important to note that while it may be more difficult to gain political support for regulatory requirements than voluntary programs, they provide a more potent tool to government agencies for reaching significant waste prevention targets.

As defined by the Organization for Economic Co-operation and Development (OECD), EPR is an environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle. There are two key features of EPR policy: (1) the shifting of responsibility (physically and/or economically, fully or partially) upstream to the producer and away from municipalities, and (2) to provide incentives to producers to take environmental considerations into the design of the product. European countries have implemented EPR programs for many years, and have had particular success with reducing packaging materials through fee systems and other mechanisms.⁶

Material or waste bans can also be powerful motivators for preventing waste, encouraging reuse, or reducing toxicity. Bans can be focused either on product inputs or on product disposal. Both are aimed at changing the practices of businesses and consumers. Some programs prohibit use of certain materials in product formulation or manufacture, such as mercury. These are generally pursued to eliminate or reduce toxic materials and are based on an understanding that viable alternative materials exist. Thus, these are often referred to as toxics substitution initiatives. Other programs ban the disposal of certain types of materials, either because of their toxicity, or their high volume in the waste stream and availability of alternative management options.

⁵ Mandatory requirements and specifications for governments to purchase environmentally preferable products (EPP) may also be considered a regulatory approach. For purposes of this review, since EPP programs are often voluntary guidelines and because their direct focus is government internal behavior, they are discussed below under Government Leadership by Example.

⁶ OR DEQ has produced an excellent fact sheet on International Packaging Regulations, which is available at: <http://www.deq.state.or.us/lq/pubs/docs/sw/packaging/intlpkgregulations.pdf>.

Program Descriptions

San Francisco, California

Following a new state regulation that bans a wide range of common household hazardous waste products from the trash, in early 2006 the San Francisco Board of Supervisors passed an **EPR Resolution** that:

- Supports statewide legislation and local initiatives requiring manufacturers to take responsibility for collecting and recycling their products at the end of their useful life;
- Urges the California Legislature to pursue statewide extended producer responsibility legislation targeted at universal waste.
- Advises the City's Department of the Environment to develop EPR policies such as leasing products rather than purchasing them, and requiring the manufacturers of products sold to City departments to offer less toxic alternatives, and to take responsibility for managing their products at the end of their useful life; and
- Commits the City and County of San Francisco to continue to support EPR initiatives.

San Francisco's EPR Resolution is one of the strongest statements to date about EPR from a local government in the U.S. The Resolution may be on the cutting edge of a shift in thinking among local governments, which have historically borne the responsibility for collecting and disposing of waste. As the resolution puts it: "By covering the costs of collection and disposal, local governments are subsidizing the production of waste because manufacturers know that whatever they produce the local government will foot the bill for recycling or disposal."

British Columbia Product Stewardship Programs

The BC Ministry of the Environment created an Industry Product Stewardship Business Plan (approved in 2002), which established the framework to support the development of the Product Stewardship Program. The program has two key features:

- Based on Extended Producer Responsibility (EPR) concepts, it places the onus for end-of-life product management (physically and/or economically, fully or partially) on producers and consumers rather than general taxpayers; and
- It provides incentives to producers to consider environmental impacts in the design of products.

To support the development of new programs, an October 2004 Recycling Regulation includes core EPR requirements for beverage containers, and includes plans to transform electronics (e-waste), tire, and battery recycling programs into EPR programs. It also provides a framework for inclusion of additional products in the EPR program by regulation, without the need for new legislation.

King County, Washington

Product stewardship is an important component of King County's 2001 Comprehensive Solid Waste Management Plan. The Solid Waste Division promotes product stewardship in order to:

- Reduce local government's waste disposal costs by sharing the responsibility for managing certain wastes with manufacturers, retailers and consumers;
- Reduce the use of toxic materials in products; and
- Conserve resources by encouraging waste prevention, reuse and recycling through good product design.

The King County Product Stewardship and Strategies report (2002) focuses on the county's initial stewardship targets: electronics equipment and products containing mercury, provides background information on policies, and describes how target products and materials are selected. The County's Solid Waste Division is a member of regional and national organizations (the Northwest Product Stewardship Council, and the Product Stewardship Institute), that work with businesses, government agencies and nonprofit groups to promote product stewardship principles and reduce the health and environmental impacts of consumer products.

As part of its overall strategy, the County established the Take it Back Network and initiated the Regional Take it Back Pilot Projects (funded by grant as part of EPA's Plug-In To eCycling Campaign) to collect and reuse or recycle used electronics. It has also been a key player in the development of recent WA state legislation to require the take back of certain electronics.

Germany Packaging Ordinance and the Green Dot Program

In 1991 Germany established the Ordinance on the Avoidance of Packaging Waste (Packaging Ordinance). The Ordinance was expanded several times, and as of 1993, required all manufacturers—foreign and domestic—to take back and recycle or reuse all types of consumer packaging used to contain and transport goods from the point of sale to consumption. Manufacturers, retailers and distributors may be exempt from the Ordinance if they participate in the Duales System Deutschland GmbH (DSD), or Dual System of Germany. The DSD, set up in 1990 as a non-profit, collects, sorts and recycles post-consumer packaging from households and businesses throughout Germany. This prompted an industry initiative, the Green Dot Program, to avoid individual take-back regulations. Participants in this system label their products with the Green Dot, which indicates that packaging should not be returned to the manufacturer or distributor, but instead should be collected and recycled through the DSD.

The DSD:

- Maintains over 600 companies as members.

- Requires its members to pay a license fee (for the Green Dot trademark) based on the type and weight of the packaging materials (this acts as an incentive for waste prevention).
- Requires members to adhere to certain standards for the use of certain types of packaging materials.
- Motivated the European Union to implement the European Packaging Directive (1994) to standardize national measures and set recovery targets for packaging.
- Is now licensed to 20 other EU countries who are trying to comply with the Packaging Directive.

While the Packaging Ordinance has established an elaborate system for recycling packaging materials that exists side-by-side with curbside programs, it has also provided an important incentive to prevent waste through packaging redesign and minimization.

The Netherlands Packaging Covenant III

The Netherlands has also focused on reducing and recycling product packaging, using a voluntary system based on a series of covenants. The first Packaging Covenant was signed in 1991. The third Packaging Covenant (PC III) came into effect in 2002 and expired in January 2006. It is being replaced by the Packaging, Paper and Board Management Decree to govern waste collection, prevention and recycling. The new approach will require producers to pay for the separate collection or post-separation of household packaging waste. Since 1991, the PC has been successful in continuously reducing the use and disposal of packaging material and consequently the environmental impact of packaging waste. In the early years, reductions in packaging waste were on the order of 6-15% per year. In the last few years, however, reductions have declined to about 1-2% per year. The program's monitoring system has been reviewed and altered many times since 1991, and requires ongoing scrutiny and refinement.

Objective for prevention of packaging: The Packaging Covenant stipulated that the total volume of packaging would not rise by more than two-thirds of the percentage increase of GDP between the years of 1999 and 2005. This objective recognizes the need to decouple waste generation and economic activity. The GDP grew by 10.2% during this period, while the total volume of new packaging on the market increased by 8.8%, exceeding the objective's target of no more than 6.8%.

Challenges

Several challenges are associated with the implementation of regulatory requirements. The first is political will. While mandatory programs and requirements are often considerably more effective than voluntary ones, there is frequently resistance to new regulations by certain stakeholders because they may require changes and potential cost increases in established manufacturing processes or business practices. The political power of such opponents can often inhibit the adoption of strong mandatory programs. Implementing effective processes in which stakeholders with different interests are engaged in the development of new regulations can be time-consuming and difficult. The

second challenge relates to enforcement, which is closely linked with resources and staffing constraints on the part of governments. A lack of human and financial resources can significantly weaken regulatory program effectiveness.

Assessment

Experience in several jurisdictions, including Massachusetts, British Columbia, Germany, and elsewhere, has demonstrated that regulatory programs can have an important impact on preventing waste and encouraging reuse. Germany (through the Green Dot program) is a leader in Europe for packaging reduction and recycling. Between 1990 and 2004, the DSD has led to a 14% decrease in per capita consumption of packaging.

The Massachusetts waste bans, combined with effective public education, have been enormously successful in promoting home composting and preventing yard waste from entering the waste stream. Also, regulatory requirements often spawn related product redesign efforts by manufacturers to prevent waste and facilitate product collection and reuse. While many programs do not systematically track their waste prevention impacts, and it is difficult to do so, establishing reduction targets and an accepted method for tracking progress can be an effective way to motivate businesses, consumers, and agency staff responsible for program implementation. EPR programs offer governments a tool to shift responsibility for end-of-life product management by internalizing the external environmental costs of goods and services, and are a means to help reshape how society thinks about production and consumption behavior. In the absence of national regulations, regional efforts such as the Northwest Product Stewardship Council promote broader adoption of EPR approaches, which may lessen the burden of multiple state-level requirements on manufacturers.

Government Leadership by Example

Overview

Government leadership and involvement in waste prevention programs has a strong bearing on program effectiveness. There are numerous reasons for governments to champion waste prevention programs, including: demonstration that such programs are feasible, and that governments should play a role in reducing a state's waste generation; incorporation of policies and tactics in the public realm that the government recommends to others; and transfer of lessons learned and best practices with other governments.

Government leadership is demonstrated in several types of programs, including Environmentally Preferred Procurement/Purchasing (EPP), setting regional targets for waste prevention and reduction, and internal practices such as duplex copying and green building.

Program Descriptions

California Integrated Waste Management Board (CIWMB)

In 1999 new California legislation (AB 75) required state agencies and large state facilities to divert at least 25 percent of their solid waste from landfill disposal or transformation facilities by January 1, 2002, and at least 50 percent by January 1, 2004. Diversion was defined to include reducing potential waste by means such as source reduction, recycling, and composting. Under the law, each state agency and large state facility must adopt and submit an integrated waste management plan (IWMP) to the CIWMB, which outlines the steps to be taken to achieve the mandated waste diversion goals. The law also requires state agencies and state facilities to submit annual reports to CIWMB regarding solid waste reduction beginning April 2002.

The CIWMB bolstered its efforts in November 2001 when it adopted a Strategic Plan highlighting the following themes: sustainability, product stewardship, energy recovery, environmental justice, safe disposal of waste, and the promotion of a zero-waste philosophy. The last goal, "Zero-Waste," is an outstanding waste prevention effort by a public entity, and the details and objectives for meeting the goal are outlined below.

Overview of Goal 7, Zero-Waste:

- "Promote a 'zero-waste California' where the public, industry and government strive to reduce, reuse or recycle all municipal solid waste materials back into nature or the marketplace in a manner that protects human health and the environment and honors the principles of California's Integrated Waste Management Act."
- Maximize waste reduction and use the most effective processing or manufacturing practices to optimize efficiency and conserve natural resources through both

front-end (e.g. source reduction) and back-end (e.g. recycling) methods as well as by using waste to generate energy.

Goal 7 Objectives:

- Promote source reduction to minimize the amount of waste generated.
- Promote best business practices in product manufacturing and handling.
- Encourage recycling activities and new technologies in all business and residences.
- Promote new or existing technologies and processes to address existing or emerging waste streams.
- Work with other State agencies to promote zero-waste strategies that would ultimately put State agencies in a position to lead by example.

San Francisco, California

San Francisco has a number of innovative City programs that promote waste reduction and reuse through government leadership:

- **Precautionary Principle** - In 2003 the San Francisco Board of Supervisors adopted a set of environmental regulations for the City and County of San Francisco that recognizes the Precautionary Principle as the guiding model for future legislation. This approach asks whether a given product or practice is safe, whether it is really necessary, and whether products or practices with less environmental impact would perform just as well.
- **Green Building** – The City’s Environmental Code (Chapter 7) reflects San Francisco’s commitment to green building and requires that new municipal buildings and significant renovations of 5,000 square feet or more meet the LEED Silver standard. It also established the interagency Resource Efficient Building (REB) Task Force to guide development of City green building standards and oversee their implementation. The Department of Environment published an extensive *Green Building Compliance Guide for San Francisco Municipal Buildings* as a resource and step-by-step guide for professionals working on the planning, design, construction, operation, and demolition of City buildings.
- **Less-toxic Purchasing** – San Francisco’s Environmentally Preferable Purchasing Program works to minimize the purchase of products containing hazardous ingredients used in the City's custodial services, fleet maintenance, and facility maintenance in favor of using alternate products that pose less risk to City employees and to the environment. The Program develops guidelines to determine when the City should make purchasing changes to support the goal of using of less harmful products, and has developed a list of environmentally preferable practices and products for City Departments to use. This is institutionalized in the Environmentally Preferable Purchasing Ordinance, which is Chapter 2 of the City and County of San Francisco Environment Code.

Seattle

Seattle's Paper Waste Prevention Campaign aims to reduce the environmental impact associated with the City's purchase, use and recycling of printer and copier paper through reducing overall consumption of paper and other practices. Executive Order (2005) calls for City departments to reduce paper consumption by 30% by end of 2006 and purchase 100% recycled content paper. Progress towards the 30% reduction goals is included as part of the performance evaluations of department managers. From January to May, 2006 the City's paper consumption fell 8-12% compared with the same period in 2004.

King County, Washington

The Green Building Ordinance in King County, adopted in 2005, charges all County departments to incorporate the LEED rating system as the standard for all projects. The County established a Green Building Team consisting of representatives from various departments including Natural Resources and Parks, Transportation, Development and Environmental Services, Finance, and Executive Services. The team has expertise in project management, architecture, design, landscape architecture, engineering, resource conservation and budget analysis, and promotes the use of green building practices in all buildings that the county constructs, remodels and renovates.

Challenges

Several challenges pertain to the Government Leadership by Example programs, not the least of which is budgeting the necessary resources to initiate and maintain programs. There are also logistical challenges in implementing many of the above programs in terms of ensuring that the appropriate infrastructure exists for material reuse. For example, maximizing the reuse of C&D materials (or used office equipment) requires adequate collection and storage infrastructure as well as creation or facilitation of ready markets to utilize the C&D materials.

Assessment

CIWMB claims to have been extremely successful, as state agencies reported diverting 77% of their total waste by 2002, far surpassing their target of 25% waste diversion by 2002 and 50% by 2004. While some of the diversion from disposal resulted from waste prevention and reuse, the fraction is not readily available, but it is clear that the majority was from recycling.

Perhaps the greatest success for Government Leadership by Example programs is in the area of EPP. Many states, including Massachusetts, have implemented aggressive green procurement programs that have had significant impacts in promoting a whole range of environmentally preferred products from chlorine free paper with high post-consumer content, to building specifications requiring waste preventing building techniques. Some states, including Massachusetts have achieved standard price contracts with suppliers of such products that allow municipalities and other non-state public agencies to purchase these goods and services under the same preferential terms as the state. Estimates of the

value of purchases under EPP programs is in the billions of dollars annually for some of the larger states.

The green building area in particular has seen considerable success, and as states' experience has increased many have moved from an EPP focus to an integrated design approach in which the whole building is looked at as an integrated system from the outset. The result is not only the prevention of significant amounts of construction waste, but also reductions in energy and water resources, and their associated costs, used throughout buildings' lifecycle.

European Sustainable Consumption Initiatives

Overview

While technological development and innovation have significantly increased resource efficiency and improved environmental outcomes in the U.S. and elsewhere, increased consumption and changes in lifestyles associated with increased wealth tend to outweigh such gains. “Sustainable consumption” initiatives in Europe are at the cutting edge of waste prevention efforts and address deep issues concerning values and lifestyle choices. The potential of these programs for waste reduction goes far beyond conventional programs. They are, therefore, given special focus in this section. Here we highlight both the broad initiatives at the EU level, as well as selected best practices at the member country level, where much of the policy formulation and implementation activity occurs to influence consumption habits and environmental performance. This review is not intended to be exhaustive, as there are a myriad of local, national, and EU-wide sustainable consumption efforts underway. Rather, it is meant to provide a clear sense of the European framework and an understanding of selected key accomplishments in this area.⁷

In 2002 at the World Summit on Sustainable Development in Johannesburg, European Union (EU) countries pledged to advance policies for sustainable consumption and production (SCP). The European Council followed up on this commitment in 2003 by developing a ten-year framework. This 10-year framework, as part of the Marrakech process (named after the location for the first International Expert Meeting in June 2003) includes the creation of a Regional Strategy on Sustainable Consumption and Production and an accompanying Regional Council of Government to oversee the ten-year framework.⁸

Following commitments “to promote sustainable patterns of production and consumption” made at the 2002 World Summit, the EU has developed a range of instruments to promote **sustainable consumption and production**, including:

- Integrated Pollution Prevention and Control (IPPC)
- EU Eco-Management and Audit Scheme (EMAS)
- EU proposed directive on eco-design and end-use products
- Social and fair-trade labels
- Thematic strategy on waste prevention and recycling

⁷ It is important to note that according to the OECD, per capita solid waste generation in Europe is already significantly lower than in the U.S. (e.g., approximately 50% less in Germany and 30% less in France).

⁸ Given the depth of economic and social transformation required to successfully implement SCP programs, a number of countries in the EU, including the United Kingdom, recognize that SCP efforts have to look well beyond ten years.

- Thematic strategy on the sustainable use of natural resources
- New framework for taxation of energy products and electricity
- Integrated Product Policy (IPP)
- New EU chemicals policy (REACH)
- EU Environmental Technology Action Plan.

The European Union places its sustainable consumption policies and initiatives within the larger context of the EU's sustainable development initiatives, including the EU's Lisbon Strategy of Economic and Social Renewal (2000), the Sustainable Development Strategy (Gothenburg, 2001), and the Sixth Community Environment Action Programme (6EAP). The primary objective of the Lisbon Strategy is to make the EU the world's "most competitive and dynamic knowledge-based economy" by 2010. The Sustainable Development Strategy supplemented the Lisbon Strategy by bolstering the emphasis on environmental protection, and the need to promote economic, social and environmental objectives simultaneously. The 6EAP focuses on environmental goals for the EU, including in the area of waste prevention and recycling, and lays out the key objectives, central to which are efforts to decouple environmental pressure and economic growth. These sustainable development policies provide a useful context for both understanding the EU sustainable consumption efforts, and also for evaluating the transferability and applicability of EU SCP approaches to Massachusetts.

Program Descriptions – EU Level

The initiatives that comprise the EU SCP effort fall into several categories outlined below. In this section we highlight those that appear to be most relevant for potential use in Massachusetts.

Resource Productivity Improvements

- *EU Environmental Technology Action Plan (ETAP)*
 - Survey to identify technology that can effectively address environmental problems.
 - Identification of barriers that inhibit development and implementation of these technologies.
 - Development of action plan to address barriers.
- *The Sixth EU Framework Programme for Research and Technological Development*
 - Focuses on changing industrial processes and projects to promote SCP and highlights long-term research activities to enhance SCP objectives.

Alternative Business Models

- *Corporate Social Responsibility*
 - Campaign and toolkit to raise awareness about CSR (65 national events in 25 countries).

Public Awareness and Action

- *Environmental labeling*
 - The EU eco-label (the Flower) was introduced in 1992. A current initiative is in the midst of broadening the range of eco-label criteria.
- *Report on Sustainable Household Consumption in Europe*
 - European Environment Agency drafted a contribution to the next “State of the environment and outlook” report, describing sustainable household consumption in Europe including past trends and future projections.

Economic Incentives

- *Economic Instruments*
 - Environmentally-related taxes (energy, water, etc.)
 - State aid for environmental purposes.
 - Trade policies and preferential tariffs

Regulatory Requirements⁹

- *Integrated Product Policy (IPP)*
 - Improve existing mechanisms (the IPP “toolbox”) to make them more product-focused, and optimize the synergies between mechanisms.
 - Target products with the greatest potential for improvement and enhance their environmental performance.

Government Leadership by Example

- *Public Procurement Policies*
 - Commission Communication about the possibilities for basing public procurement policies on environmental and social factors.

⁹ Through an earlier regulatory initiative, the European Commission’s Landfill Directive (Council Directive 99/31/EC) set aggressive reduction targets for municipal biodegradable waste going to landfills (reaching 65% reduction by 2013). This serves as another incentive for EU countries to pursue SCP and other waste prevention strategies.

- Handbook on Green Procurement—provides detail on items in the Commission Communication and gives specific examples on how to incorporate environmental considerations into public procurement policies.
 - In 2004, adoption of public procurement Directives that establish guidelines for adopting environmental and social considerations into procurement policies.
- *Analytical Tools*
 - Indicators: developed by the Commission in order to track progress on meeting SCP and sustainable development goals. Task force created an indicator framework with ten themes including SCP. The indicators will be revised periodically.

Program Descriptions – National Level

Key sustainable consumption programs in Europe at the national level include:

- Austria: Eco-efficiency Action Programme
- Finland: National Programme on Sustainable Consumption and Production
- Germany: National Process of Sustainable Consumption and Production
- United Kingdom: Government Framework for Sustainable Consumption and Production, and the UK National Resource and Waste Forum

Several other European countries have also introduced sustainable consumption efforts in recent years, including Hungary's Network for Sustainable Consumption and Production, but there is little information to date on the effectiveness of these efforts.

Finland National Programme on Sustainable Consumption and Production

Based on the work of a multistakeholder advisory committee comprising government, business, environmental and consumer interests, in June 2005 Finland released its National Programme to promote sustainable consumption and production. The key objectives of the Programme are to increase the efficiency of the usage of materials and energy through all stages of product life cycles, and to promote environmental education and the development and adoption of environmental technologies. Finland's Programme recognized that its key challenges included: high usage levels of natural resources, significant harmful environmental impacts outside of Finland due to Finnish consumption and production patterns, and high greenhouse gas emissions.

The committee's proposals include 73 specific measures, and acknowledged that new kinds of policy instruments will be required to reach the proposed targets, including financial incentives such as taxation schemes that encourage eco-efficiency, and leading by example in the public sector regarding public works and purchasing policies.

Importantly, the committee stressed that the quality of life should not be defined primarily by the ownership of material goods. Its recommendations aim to encourage innovations that improve the availability of services, communally owned goods and rentable products. These are examples of the deep changes in lifestyles mentioned in the overview of the European sustainable consumption initiatives, above.

To improve resource productivity, the Programme calls for support of research on technologies and financial instruments to promote more efficient production processes and waste prevention, special service centers to provide technical assistance to businesses, and the development of more concrete targets for improvements in material- and energy-efficiency, and reductions in waste. There is also a focus on promoting new product-service concepts and environmental management systems in the construction sector that encourage favorable waste management practices. Other elements include a strong commitment to public sector purchasing strategies to ensure that environmental considerations are integrated into all public sector purchases.

United Kingdom Framework for Sustainable Consumption and Production

The UK Framework for Sustainable Consumption and Production was published jointly by the Department of Environment, Food and Rural Affairs (Defra) and the Department of Trade and Industry (Dti) in 2003. It describes how the UK is implementing its commitments made at the WSSD and subsequent EU meetings. The Framework focuses on decoupling economic growth and environmental degradation, prioritizing efforts based on the most pressing environmental threats, increasing resource efficiency in production of goods and services, and leveraging market changes through government procurement practices and incentives. It calls for taking a holistic approach that considers entire life-cycles of products and services, and intervening as early as practicable in the resource/waste flow process.

The Framework also recognizes the importance of engaging the full range of stakeholders in devising effective SCP initiatives, and suggests that a policy package, rather than a single instrument, is necessary. To date, the UK's SCP efforts have included initiatives on energy, water, vehicles, waste, and the use of economic instruments.

Efforts involving economic instruments focus on environmental taxes and are consistent with the UK government's view that decoupling economic growth from environmental degradation requires policies to address externalities. The Climate Change Levy, the landfill tax, and the aggregates levy are all attempts to reflect external costs, implement the "polluter pays" principle, and increase resource productivity. The Aggregates Levy introduced in 2002, for example, reduces demand for primary aggregates (sand, gravel, and crushed rock) by increasing their cost and encourages the use of recycled and secondary materials. The Aggregates Levy Sustainability Fund aims to reduce the environmental impacts per ton of aggregates extraction and helps to stimulate the market for recycled and secondary materials. Similarly, the landfill tax, introduced in 1996, has been increased significantly over time – to £21 per ton for 2006/07 and is expected to increase by at least £3 per ton a year until it reaches a medium to long-term rate of £35 per ton. The government is considering extending it to other methods of disposal, namely incineration, to further promote waste prevention, reuse and recycling. In addition to

taxes, a number of funding programs have been established in the UK to stimulate technological innovation to improve resource productivity.

Finally, through its new approach to “sustainable procurement” the UK government aims to use the public sector’s significant buying power to steer the marketplace and provide incentives for environmentally preferable products. With existing commitments regarding procurement of paper, timber, renewable electricity and alternative fuel vehicles in place, there is considerable room for expansion and improved coordination.

United Kingdom National Resource and Waste Forum

In 2001 the UK National Resource and Waste Forum was created. The Forum builds cross-sectoral solutions and promotes sustainable resource and waste management. It is open to parties committed to realizing these goals and comprises government agencies, businesses, NGOs, and others. The Forum has established the UK Framework for Waste Prevention to address the link between increased wealth and waste, and to inform sustainable consumption efforts. There are three phases of this effort 1) information gathering; 2) program development; 3) program delivery and evaluation. The Phase 1 report (August 2003) was intended to inform policy development and focus on priority waste streams with high potential prevention, such as organics (kitchen food wastes), packaging (plastic, glass, paper, metal), paper (non-packaging), single-use disposable products, white goods, electronics, and furniture. It also identified three waste prevention components:

- **Demand side:** consumers and communities
- **Supply side:** retailers and manufacturers
- **Policy side:** legislative change

The Forum initially focused on addressing the **demand side** through a local action toolkit with the following elements:

- **Home and community composting** of yard, food and other organic waste
- potentially 25-30% of household waste
- **Smart shopping** - how the consumer can reduce packaging waste and single use products
- **Paper waste** - how householders and community groups can stop unwanted mailings
- **Product life** - how the community can encourage repair and reuse of products including resale/redistribution
- **Service systems** - how new businesses can be created which will reduce disposal such as diaper laundering and hire services

The Forum is currently developing programs for the **supply side** including:

- Packaging workshops for the supply chain
- Eco design support for producers

- Re-use schemes for refillable packaging
- Measures to reduce production of unwanted mailings
- Measures to moderate growth in single use products

Policy side initiatives are also underway:

- Measures to reduce production of unwanted mailings
- Measures to moderate growth in single use products
- Grading systems to encourage life extension of high value products

Challenges

This section describes several challenges that have emerged from the European SCP efforts. We have focused on the experience in Western Europe, rather than in Central and Eastern Europe, as we believe the experience in the west is more applicable to Massachusetts. Some of the primary challenges to date are as follows:

- Sensitivity around questioning lifestyles and the cultural notions equating consumption with quality of life
- De-coupling environmental degradation and natural resources use from economic growth
- Integrating policies intended to address SCP issues. Many such policies operate on different timelines and with different progress indicators and therefore do not optimize synergies between the efforts.

The first challenge listed above—reconsidering lifestyle choices and changing consumer behavior—gets at the core of SCP efforts. Altering consumer values and lifestyles is critical to achieving environmental stewardship beyond levels typically achieved through waste prevention efforts. A review of SCP efforts in 2004 noted that resource use, pollution and waste generation are all expected to continue to increase in Europe due to increased material consumption relating to consumer trends.

The task of reducing consumption is particularly difficult because it requires targeting a variety of variables, and it is often difficult to isolate the impacts of each variable, let alone the interaction between them. For example, it is hard for policy analysts and regulators to distinguish between drivers of individual consumption (affected heavily by personal income, prices, diversity of products, etc.) and societal consumption (affected primarily by macro-level demographic, economic, technological, institutional, socio-cultural and environmental factors) for the purposes of tracking and reducing overall consumption.¹⁰ In addition, it is often difficult to isolate consumption and production

¹⁰ Background Paper: European Stakeholder on Sustainable Consumption and Production. Ostend, Belgium, November 25-26, 2004. (2.1)

patterns from each other; changing the design and production of products will likely influence consumers' purchasing patterns and create new feedback loops.¹¹ Given the strong cultural inclination in the U.S. towards increasing material possessions and against strong governmental regulation and tax policies, it is reasonable to expect that the task of altering consumer patterns and behavior will be even more difficult to address in the U.S. than in Europe.

Assessment

In working to develop SCP policies, one must account for the fact that SCP crosses many sectoral and topical boundaries. As such, a varied package of coherent policies—informed by consultation with stakeholders—is critical to a successful effort. In addition, there is a strong need to go beyond technological and efficiency-related policies to target consumer values and lifestyle choices. A coherent package would include supply, demand, and policy-oriented tools, with much attention given to policies targeting producer and consumer behavior—namely, focusing on economic instruments and education.

In examining and deciding upon economic instruments to promote SCP, there are several important issues to consider—many of which relate to market failures. The most prominent is the presence of externalities, and incorporating these into SCP policies. As shown in the UK experience, this is particularly critical for decoupling economic growth from environmental degradation. The UK has initiated a new technique for achieving this; it has developed nine “decoupling indicators” that comprise a ‘basket of indicators’ for SCP. These indicators compare the environmental impacts of certain products, processes or externalities with the associated GDP and/or household consumption. The basket includes economy indicators, resource use indicators and indicators for specific sectors. The basket will be particularly useful in tracking progress towards targets, and helping policy makers assess the extent that various sectors still need to be decoupled.

Other issues for consideration in developing SCP-related economic tools include imperfections in the market such as asymmetrical information, the lack of competition in certain sectors, contractual problems that can present barriers for efficient resource use, a shortage of appropriate skilled labor, access to capital, and methods for stimulating innovation while shifting and restructuring the economy.

Educational efforts will help address both an inclination towards material consumption as well as information failures that may lead consumers to harmful products. One critical message to get across to consumers is that small lifestyle choices can have large implications for the environment and the economy. Governments and other parties should use information, regulation, and economic incentives to raise consumer awareness and promote SCP. Effective examples from the UK and elsewhere include eco-labeling, differential tax rates, and a variety of price signals.

¹¹ Id.

APPENDIX 2

Documentation for the Morris Environmental Benefits Calculator (MEBCalc) Model

Documentation for the Morris Environmental Benefits Calculator (MEBCalc) Model

Draft

Prepared by:

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June 30, 2008

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1. Introduction and Summary¹

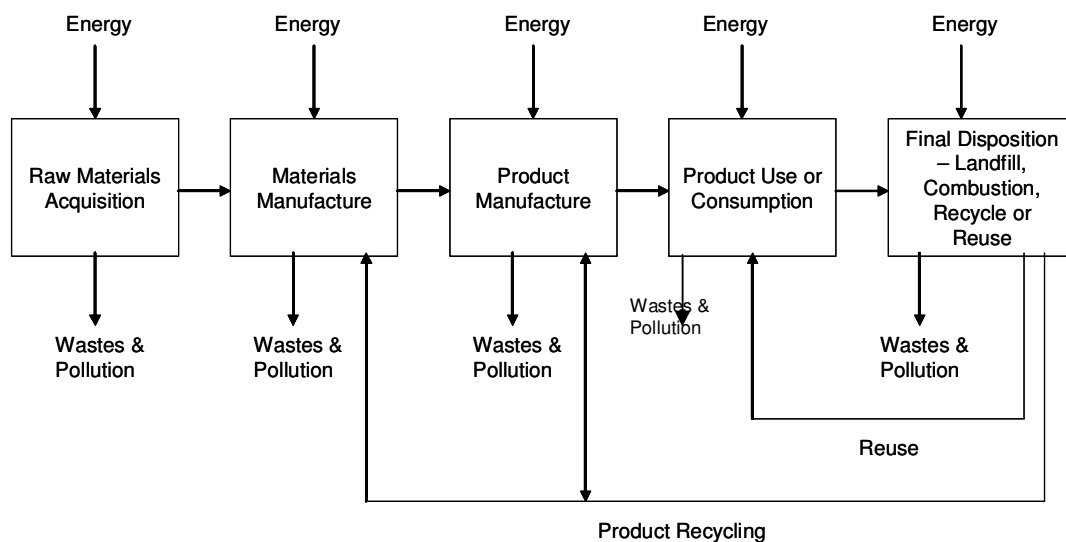
Figure 1, Schematic Detail for a Product's Life Cycle Phases, provides a conceptual diagram for the life cycle of a product or service. It depicts the input of energy and output of wastes and pollution that occur over the three phases of a product's life cycle:

- Upstream phase -- resource extraction, materials refining, and product manufacturing,
- Use phase – product use, and
- End-of-life phase – management of product discards.

The Figure 1 schematic indicates how reuse and recycling short circuit the upstream phase, thereby conserving energy and reducing releases of waste and pollutants in the production of goods and services. Most of this environmental value comes from pollution reductions in the manufacture of new products made possible by the replacement of virgin raw materials with recycled materials and the replacement of synthetic petroleum-based fertilizers with compost.

Figure 1

Schematic Detail for a Product's Life Cycle Phases



One or limited number of return cycles into product that is then disposed – open-loop recycling.
Repeated recycling into same or similar product, keeping material from disposal – closed-loop recycling.

¹ This documentation was prepared for the King County, Washington Solid Waste Division, June 2008.

Composting organic materials adds environmental value in two important ways:

- 1) Diversion to composting prevents methane generation when materials with high anaerobic decomposition propensities, such as food scraps, are composted rather than landfilled.
- 2) Soils fortified with compost need fewer or no applications of synthetic fertilizers and pesticides, thus preventing pollution that would otherwise be released during production and use of fertilizers and pesticides.

To estimate the environmental value for curbside recycling and composting, Sound Resource Management developed a comprehensive recycling and composting environmental costs and benefits valuation model.² The model includes a “best-of” compendium of life cycle data from a number of environmental life cycle inventory and assessment models, including:

- US EPA’s WARM model (available on the internet at http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html)
- US EPA’s MSW Decision Support Tool (available through Research Triangle Institute³)
- Carnegie Mellon University Green Design Institute’s Economic Input-Output Life Cycle Assessment model (available on the internet at www.eiolca.net)
- US NIST BEES model (available on the internet at <http://www.bfrl.nist.gov/oae/software/bees/model.html>)
- US EPA’s TRACI model (information about TRACI is available on the internet at <http://www.epa.gov/nrmrl/std/sab/traci/>)

Our model also uses life cycle data from the Consumer Environmental Index (CEI) model we developed for the Washington State Department of Ecology⁴, as well as from peer-reviewed journal articles including Morris (1996), Morris (2005), and Morris and Bagby (2008).

This model estimates pollution reductions across all three phases of product life cycles that are caused by diverting material discards to recycling or composting. The model takes into account pollution emissions from collection vehicles, recyclables processing facilities, composting facilities, disposal facilities, and shipping of processed materials to end users.

Table 1, Estimated Environmental Value per Ton Recycled or Composted, shows the environmental value for each type of material collected by curbside recycling and composting

² The model is reviewed in Morawski (2008).

³ See Research Triangle Institute (1999a and 1999b)

⁴ The CEI model is detailed in Morris *et al* (2007).

programs. Environmental benefits by material type range between \$67 per ton for yard debris composting to \$1,458 per ton for aluminum can recycling.

Table 1
Estimated Environmental Value per Ton Recycled or Composted

<i>Recycled Materials</i>	<i>Environmental Value Per Ton</i>
Newspaper	\$329
Cardboard	450
Mixed Paper	179
Glass Containers	55
PET Plastic Containers	580
HDPE Plastic Containers	203
Other Plastic Containers	203
Plastic Film & Bags	203
Aluminum Cans	1,458
Tin-plated Steel Cans	65
Ferrous Scrap	65
<i>Composted Materials</i>	
Yard Debris	\$67
Food Scraps	97
Paper & Cardboard	71

The environmental benefits estimates shown in Table 1 are based on pollution reductions that decrease the potential for seven categories of damage to public health and ecosystems⁵:

- Climate change,
- Human disease and death from particulates,
- Human disease and death from toxics,
- Human disease and death from carcinogens,
- Eutrophication,
- Acidification, and
- Ecosystems toxicity.

Life cycle analysis and environmental risk assessments provide the methodologies for connecting pollution of various kinds to these seven categories of environmental damage. For example, releases of carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs) and other pollutants cause global warming which leads to climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC) has

⁵ See Bare *et al* (2003) and Lippiatt (2007) for a detailed description and discussion of these environmental impact categories.

conducted and reviewed scientific data to determine the strength of each pollutant relative to carbon dioxide in causing global warming. For example, over a hundred year time frame methane is 23 times and nitrous oxide 296 times more harmful than CO₂. Based on these global warming potential factors we can aggregate the emissions of all greenhouse gas pollutants into a single indicator quantity for global warming potential. This quantity is CO₂ equivalents (herein denoted eCO₂).

Similar scientific efforts enable us to express the quantity of pollutant releases in terms of a single indicator quantity for the other six categories of environmental damage. This greatly simplifies reporting and analysis of different levels of pollution. By categorizing pollution impacts into a handful of categories, the environmental costs and benefits model is able to reduce the complexity of following trends for hundreds of pollutants. This simplifies life for policy makers. The trade-off is that we have to sort through complex pollutant aggregation and weighting methodologies. As described in SRMG's report on our development of a Consumer Environmental Index (CEI) for the Washington State Department of Ecology, a "best-of" methodology is in development by the United Nations Environment Program and the Society of Environmental Toxicologists and Chemists.⁶ Until that study is released, the environmental valuation model relies on the methodologies used in US EPA's TRACI (Tool for the Reduction and Assessment of Chemical and other environmental Impacts) model and the Lawrence Berkeley National Laboratory's CalTOX model.^{7, 8}

The methodology for aggregating pollutants into environmental impact categories yields total pollution reductions in terms of an indicator pollutant for each impact category. These indicators are:

- Climate change – carbon dioxide equivalents (eCO₂),
- Human health-particulates – particulate matter less than 2.5 microns equivalents (ePM_{2.5}),
- Human health-toxics – toluene equivalents (eToluene),
- Human health-carcinogens – benzene equivalents (eBenzene),
- Eutrophication – nitrogen equivalents (eN),
- Acidification – sulfur dioxide equivalents (eSO₂), and
- Ecosystems toxicity – herbicide 2,4-D equivalents (e2,4-D).

⁶ See Morris *et al* (2007).

⁷ Bare (2002) and Bare *et al* (2003).

⁸ See a description of the CalTOX model, references, and downloadable manual and software at <http://eetd.lbl.gov/IED/ERA/caltox/index.html>.

Given the estimated pollutant reductions for each category of environmental impact, the environmental costs and benefits model attaches a monetary value to those reductions. Monetization provides a method for evaluating trade-offs between the seven types of environmental impacts, and is a standard approach within the field of environmental economics. The difficulty, as discussed in Morris *et al* (2007), is that monetization is controversial, especially regarding the issue of placing a dollar value on human and non-human lives. Nevertheless, monetization allows us to compare environmental benefits to monetary costs and benefits for recycling and composting.

The final step in estimating an environmental value for recycling and composting is, then, to determine a dollar value for the damage to public health and/or ecosystems caused by each of the indicator pollutants. The following list shows these estimated damage valuations and their sources.

- eCO₂ -- \$36 per ton based on greenhouse gas offset valuation used by Seattle City Light.
- ePM_{2.5} -- \$10,000 per ton based on Eastern Research Group (2006).
- eToluene -- \$118 per ton based on Morris and Bagby (2008).
- eBenzene -- \$3,030 per ton based on Eastern Research Group (2006).
- eN -- \$4 per ton based on Morris and Bagby (2008).
- eSO₂ -- \$661 per ton based on average of 2005 (\$690), 2006 (\$860) and 2007 (\$433) spot prices in EPA's annual acid rain allowance auction.
- e2,4-D -- \$3,280 per ton based on Morris and Bagby (2008).

The next section of this report discusses in more detail the monetization of pollution reductions. The following section explains the estimates of pollution emissions impacts from recycling and composting that we developed for the environmental costs and benefits model. References cited in this report, as well as the models and websites listed above, provide the interested reader with access to the considerable body of literature that we used in developing the model.

2. The Economic Value of Pollution Reductions

The final step in estimating an economic value for the environmental benefits of recycling and composting is to determine a dollar value for the damages to public health and ecosystems from pollution. The introduction listed an economic cost for each of the seven types of environmental damages that we have included in our analysis of the environmental costs and benefits of recycling and composting. In this section we explain the estimates for five of the impacts.

2.a. The value of greenhouse gas (i.e., eCO₂) emissions reductions

There is a very wide range of costs for greenhouse gas emissions and valuations for the benefits of reductions in those emissions. The low end for valuations is the trading price for voluntary greenhouse gas emission reductions. Operating much as the markets in sulfur dioxide emissions permits do, several markets are available for trading voluntary greenhouse gas emissions reduction pledges. One of these is the Chicago Climate Exchange (CCX). Trading values on the CCX for CO₂ reductions have been between \$1 and \$4 per ton of carbon dioxide over the past several years. Values on European carbon markets have been ten times higher than trading prices on the CCX due to the mandatory CO₂ emissions caps imposed on European greenhouse gas generators.

The upper end of the range for estimated costs of climate change is found in recent studies such as the review of the economics of climate change conducted by Nicholas Stern (2007). That study determined that a reasonable estimate for the cost of current greenhouse gas emissions was \$85 per metric ton, based on the risk of catastrophic environmental impacts in the future if substantial reductions in greenhouse gas emissions are not implemented today.

We used \$36 per ton for the cost of greenhouse gas emissions in this analysis because it is in the middle of the range between carbon dioxide market values for voluntary emissions reductions and estimated costs of severe climate change impacts if today's emissions levels are not substantially reduced. This also is the estimate used by Seattle City Light to reflect the potential costs of CO₂ emissions from electricity production.

2.b. The value of human toxics (i.e., eToluene) reductions

As with the valuation of the costs of greenhouse gas emissions, there is a wide range in the estimated costs for emissions of pollutants that are toxic to humans. Eastern Research Group (2006) found estimates ranging up to \$2,700 per ton of eToluene for the human health costs of toxic air pollutant emissions. Our very conservative estimate of monetary costs for toxic air emissions is based on a peer-reviewed study on the health effects of atmospheric emissions of mercury. That study was sponsored by the Northeast States for Coordinated Air Use Management (NESCAUM) and conducted by scientists at the Harvard Center for Risk Analysis (Rice and Hammitt 2005). The study evaluated neurological and possible cardiovascular health impacts from exposure to methyl mercury through fish consumption, where atmospheric releases of mercury result in depositions of mercury in water bodies within and bordering the U.S. These depositions lead to increases in methyl mercury concentrations in fish.

The NESCAUM study evaluated three main health effects from methyl mercury exposure – neurological decrements associated with intrauterine exposure, myocardial effects associated with adult exposure, and elevated childhood blood pressure and cardiac rhythm effects associated with *In Utero* exposure. We used the economic cost estimated in the study for only the first effect. The decrease in cognitive ability as a result of intrauterine exposure to methyl mercury is well documented and understood, whereas research on the other two health effects is not yet as extensive or thoroughly peer-reviewed.

The NESCAUM study's neurotoxicity health cost estimate for exposure to methyl mercury from consumption of fish that have bioaccumulated that toxin as a result of mercury air pollution is \$10.5 million in year 2000 dollars per ton of mercury emitted to the atmosphere. Inflating that estimate to current dollars and converting the cost to toluene emissions, the indicator substance for human toxicity, yields \$118 per ton of eToluene for the cost of pollutant emissions that are toxic to human health. This is the value we have attributed to reductions in human toxicity that are caused by diverting material resources from disposal to recycling and composting.

2.c. The value of ecosystem toxics (i.e., e2,4-D) reductions

We estimated the toxicity cost to plants and wildlife from application of a pound of 2,4-D herbicide at \$1.64. This is an updated estimate from Joe Kovach, Integrated Pest Management Program at Ohio State University, based on his research originally reported in Kovach *et al* (1992) on putting an environmental price to pesticide use.⁹ The estimate includes costs for impacts on fish, birds, bees and beneficial arthropods, but not the estimated costs developed by Kovach for impacts on human health as a result of groundwater contamination. That human health cost is captured in the human toxicity potential impact category.

2.d. The value of reductions in eutrophying emissions (i.e., eN)

In soil or waterways, the addition of large quantities of mineral nutrients, such as nitrogen and phosphorous, results in generally undesirable shifts in the number of species in ecosystems and a reduction in ecological diversity. In water, it tends to increase algae growth, which can lead to lack of oxygen and therefore death of species such as fish. Our estimate of the impact cost of releases of nutrifying compounds is based on EPA's cost-effectiveness analysis for the NPDES regulation on effluent discharges from concentrated animal feeding operations. That analysis estimated that costs up to \$4.41 per Mg of nitrogen removed from wastewater effluents were economically advantageous (US EPA 2002, p. E-9).

2.e. The value of reductions in acidifying emissions (i.e., eSO2)

We base the value of acidification reductions at \$661 per ton. This is the average of 2005 (\$690), 2006 (\$860) and 2007 (\$433) spot prices in EPA's annual acid rain sulfur dioxide emissions permit allowances auction under the Clean Air Act.

3. Emissions Impacts of Recycling and Composting

This section details the impact of recycling and composting on pollutant emissions. First, we discuss the upstream environmental benefits of recycling. Next we outline the upstream and use phase benefits of composting. Then this section of our report covers the greenhouse gas

⁹ Pesticide wash-off may be higher in a hilly urban environment than in a flat agricultural field. To the extent that Kovach relied on agricultural crop studies, his estimate of the cost to non-target plants and wildlife may underestimate the cost of pesticide applications in an urban environment.

impacts of recycling, composting, and disposal collection, hauling and facility operations. Last, we cover the other pollution impacts besides climate change of recycling, composting and disposal facility operations.

Upstream recycling emissions estimates come from the Decision Support Tool (DST) developed for assessing the cost and environmental burdens of integrated solid waste management strategies by North Carolina State University (NCSU) in conjunction with Research Triangle Institute (RTI) and the US Environmental Protection Agency (US EPA).¹⁰ The Municipal Solid Waste Life-Cycle Database (Database), prepared by RTI with the support of US EPA during DST model development, provides estimates for environmental emissions from solid waste management practices.¹¹ Upstream and use phase emissions estimates for composting are based on analyses and data discussed in Morris and Bagby (2008) and Morris *et al* (2007).

Waste material specific greenhouse gas emissions estimates for waste management activities are based on US EPA's latest WARM (Waste Reduction Model) software and report.¹² Estimates of other pollutant emissions are from the RTI/EPA/NCSU DST. The methodology for aggregating numerous emissions into impact categories is discussed in Morris (2005) and Morris and Bagby (2008).

3.a. The upstream pollution prevention benefits of recycling

Table 2, Estimated Upstream Emissions Reductions per Ton Recycled, shows the upstream emissions reductions that result when recycled materials are used in place of virgin raw materials to produce new products. For example, upstream reductions in greenhouse gases, shown as carbon dioxide equivalents (eCO₂), range from 798 pounds per ton of glass recycled into new glass containers to 19,953 pounds per ton of aluminum cans recycled into new aluminum can sheet. As a second example, upstream reductions in emissions toxic to human health, shown as Toluene equivalents (eToluene), range from 367 pounds per ton of glass to 11,986 pounds per ton of aluminum cans.¹³

¹⁰ (RTI 1999a), (RTI 1999b), (Barlaz 2003a), and (Barlaz 2003b).

¹¹ Both the DST and its Database are intended to be available for sale to the public by RTI. Contact Keith Weitz at kaw@rti.org for further information on public release dates for the DST and the Database.

¹² See EPA (2006) for a detailed description of the data and methods that support the WARM model.

¹³ Upstream emissions estimates for human toxics and carcinogens and ecosystems toxics that are available for virgin- and recycled-content steel production are limited to just three specific pollutants. This compares with scores of toxics and carcinogenic pollutant emissions reported for other recycled materials. For this reason, we do not estimate upstream impacts for tin can and ferrous scrap recycling.

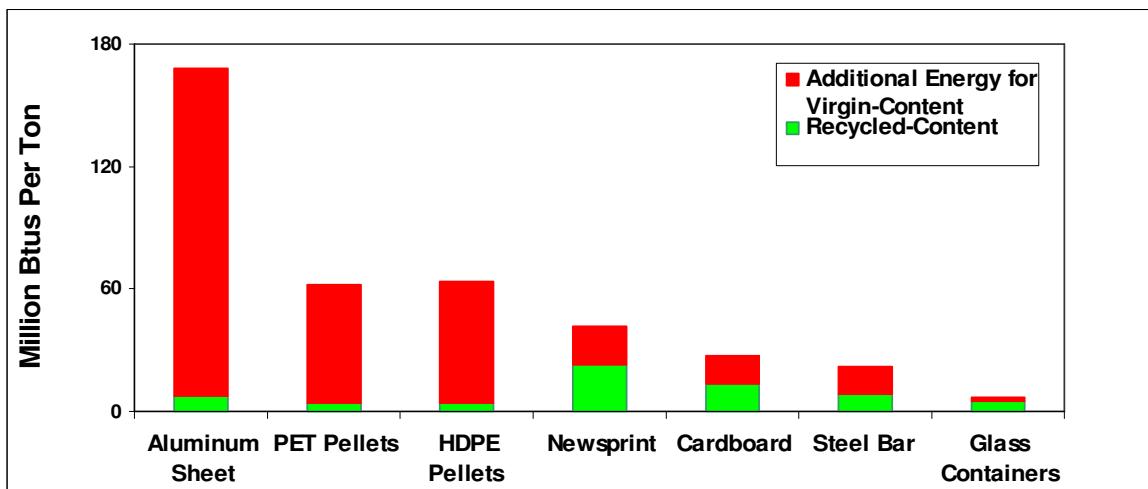
Table 2
Estimated Upstream Emissions Reductions per Ton Recycled
 (pounds of emissions reductions per ton recycled)

Recycled Materials	Climate Change (eCO₂)	Human Health - Particulates (ePM_{2.5})	Human Health - Toxics (eToluene)	Human Health - Carcinogens (eBenzene)	Eutrophication (eN)	Acidification (eSO₂)	Ecosystems Toxicity (e2,4-D)
Newspaper	7,630.4	4.5	2,849.8	0.9	-0.3	26.0	7.0
Cardboard	4,770.6	14.5	4,405.4	0.9	0.1	23.0	7.4
Mixed Paper	6,682.9	3.2	466.6	0.0	0.5	16.7	0.6
Glass Containers	797.5	4.2	366.5	0.5	0.1	4.4	1.1
PET Containers	3,574.8	4.7	7,895.1	7.3	1.8	65.3	0.7
HDPE Containers	2,814.0	2.2	2,336.1	2.3	0.7	18.2	0.2
Other Plastic Containers*	2,814.0	2.2	2,336.1	2.3	0.7	18.2	0.2
Plastic Film/Bags*	2,814.0	2.2	2,336.1	2.3	0.7	18.2	0.2
Aluminum Cans	19,953.0	37.9	11,986.4	5.8	2.9	222.0	78.4
Tin Cans	2,098.3	6.1			0.1	4.8	
Other Ferrous	2,098.3	6.1			0.1	4.8	

**Emissions for other containers, film and bags are assumed to be the same as for HDPE containers.*

Upstream pollutant emissions reductions tend to be highly correlated with upstream energy savings engendered by recycling. This correlation is due to the pollution intensive nature of most energy sources. Figure 2, Comparative Energy Usage for Virgin- vs. Recycled-Content Products, provides a graphical display of upstream energy savings from closed-loop recycling.¹⁴

Figure 2
Comparative Energy Usage for Virgin- vs. Recycled-Content Products



¹⁴ Figure 2 is based on EPA, NCSU and RTI (2003), Morris (1996), and Morris (2005).

We can use the close correlation between upstream energy usage and upstream environmental impacts to provide perspective on the positive upstream environmental benefits of recycling compared with recycling's collection, processing and hauling impacts.

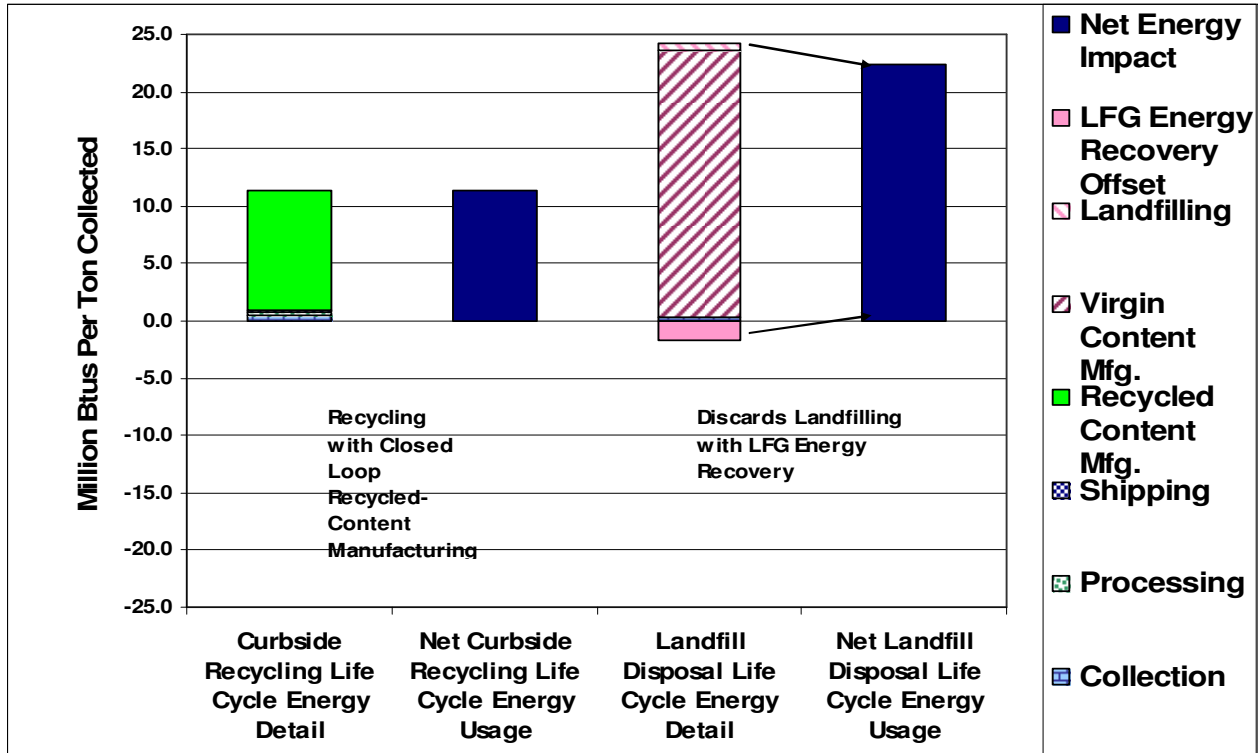
Figure 3, Total Life Cycle Energy Usage per Ton Collected – Curbside Recycling Versus Landfill Disposal with Landfill Gas Energy Recovery, shows energy usage over the life cycle of the typical ton of materials collected curbside for recycling. The bars in the graph compare energy usage for recycling a ton of curbside materials against energy usage when a ton of curbside recyclables is thrown in the garbage and sent to a landfill where landfill gases are collected and used to generate electricity.¹⁵

Figure 3 shows that manufacturing products using a ton of curbside recycled materials requires 10.4 million Btus. Collecting, processing and hauling those recycled materials to the manufacturers requires an additional 0.9 million Btus. Total energy used is 11.3 million Btus per ton recycled.

By contrast, manufacturing products using virgin raw materials uses 23.3 million Btus to extract raw materials, refine those resources into manufacturing feedstocks, and use the feedstocks to produce the same basket of goods that the recycled materials produce. Garbage collection, transfer and landfilling uses 0.8 million Btus, while the energy recovered from the landfill gases produced when the ton of recyclables decomposes anaerobically is 1.7 million Btus. This is a net usage of 22.4 million Btus per ton collected for the landfill disposal life cycle, nearly double the energy usage of the recycling life cycle.

¹⁵ See Morris (2005) for derivation of this figure.

Figure 3
Total Life Cycle Energy Usage per Ton Collected
Curbside Recycling Versus Landfill Disposal with Landfill Gas Energy Recovery



Besides the substantial energy conservation from recycling, the other conclusion to note from Figure 3 is that the 0.9 million Btus of energy used to collect and process a ton of curbside recyclables and then haul that processed material to market is an order of magnitude smaller than the 12.0 million Btus conserved by producing products from recycled materials rather than virgin resources. Also, the energy required to handle a ton of curbside recyclables is only about 12% larger than the energy needed to collect and landfill a ton of garbage.

The same sort of relationships between the upstream impacts of the recycling versus disposal life cycles, and between upstream versus collection/processing/hauling stages for recycling's life cycle that hold for energy usage also turn out to be true for climate change, human health, acidification, eutrophication and ecosystems toxicity impacts. The exact relationships vary by impact category. However, the two generalizations holds:

- Recycling beats disposal by a substantial margin for all types of environmental impacts, and,
- The environmental costs of recycling trucks and processing facilities are very small compared with recycling's upstream environmental benefits.

For example, recycled-content manufacturing produces 0.8 tons of carbon dioxide equivalents, while virgin-content manufacturing releases 3.3 tons, over four times as much eCO₂. Recycling collection, processing, and hauling operations release 0.2 tons eCO₂ per ton. In comparison, garbage collection and disposal operations release just over 1.0 tons eCO₂ per ton.

3.b. Upstream and use phase pollution prevention benefits for composting

According to Morris and Bagby (2008) and other studies referenced there, compost produced from yard debris, food scraps and compostable paper and cardboard can substantially reduce use of pesticides and synthetic fertilizers on lawns and gardens. There are as yet no systematic empirical data on the average amount of pesticide and fertilizer use reductions associated with home lawn and garden compost applications. However, one can make a reasonable argument that compost use on lawns and gardens may be associated with a 50% or more reduction in pesticides and synthetic fertilizer use. For example, the home owner who purchases compost for application on his lawn or garden presumably makes that purchase as a substitute for synthetic fertilizers and synthetic fertilizer-herbicide products.

Table 3, Estimated Upstream and Use Phase Emissions Reductions per Ton Composted, shows the pollution that is prevented when production and use of pesticides and synthetic fertilizers on lawns and gardens is reduced by 50%. These reductions are engendered by homeowners switching to a more natural lawn and garden maintenance program as a result, in part, of their decision to use compost in place of synthetic fertilizers.¹⁶

Table 3
Estimated Upstream and Use Phase Emissions Reductions per Ton Composted
(pounds of emissions reductions per ton composted)

<i>Environmental Impact</i>	<i>Indicator Pollutant</i>	<i>Emissions Reduction</i>
Climate Change	eCO ₂	1,072.3
Human Health - Particulates	ePM _{2.5}	0.5
Human Health – Toxics	eToluene	287.0
Human Health – Carcinogens	eBenzene	0.3
Eutrophication	eN	5.3
Acidification	eSO ₂	2.3
Ecosystems Toxicity	E _{2,4-D}	4.9

¹⁶ Estimates of emissions from production and use of pesticides and synthetic fertilizers are based on Morris and Bagby (2008), Morris *et al* (2007) and the CEI model, and the Carnegie Mellon Economic Input Output – Life Cycle Analysis model described in Cicas *et al* (2006) and available on the Internet at www.eiolca.net.

3.c. Greenhouse gas(GHG) emissions from discards management

Table 4, Estimated Greenhouse Gas Emissions from Discards Management, shows the carbon dioxide equivalent emissions from collection, transfer, and landfill disposal of recyclable and compostable materials, as well as from collection and recycling or composting of those materials. Collection trucks and transfer, disposal, recycling and composting facility operations result in differing amounts of GHG emissions, depending on the types and energy intensity of equipment used for these different components of a solid waste management system. But the handling of different types of waste material on a collection truck or by equipment at a given type of facility tends to yield the same amount of greenhouse gas (GHG) emissions irrespective of material type.¹⁷ This is why the estimates for GHG emissions from recycling systems are the same across all recycled material types shown in Table 4. Also, as shown in Table 4, compostable materials all have the same GHG emissions when composted, and their GHG emissions are different than the GHG emissions for materials that are recycled.

However, materials have different decomposition characteristics in the landfill, causing differing amounts of carbon sequestration, methane generation, and energy recovery potential. This accounts for the differences in GHG emissions shown in the Disposal eCO₂ Emissions column of Table 4. For example, disposal of yard debris and compostable paper/cardboard in a landfill that collects 75% of generated landfill gases and uses those gases to generate electricity actually decreases GHG emissions.¹⁸ For those materials the carbon sequestered in the landfill plus the electrical energy grid offset from the collected methane outweigh the climate change impact of the methane that is not captured by the landfill's gas collection system.

Food scraps, on the other hand, generate more GHGs in the form of methane than the portion of their carbon sequestered in a landfill plus the greenhouse gas emissions avoided from energy generated by the collected methane. This makes food scraps a net GHG generator, even in landfills that are highly efficient at recovering energy from landfill gases.

Energy generated from landfill gases provides a GHG credit as a result of the emissions avoided that would otherwise be generated in electrical power plants that feed the electricity grid in the Northwest. Natural gas is the source of incremental energy on the Northwest grid, and the GHG emissions from this fossil fuel are avoided when electricity is generated from collected landfill gases.¹⁹

¹⁷ See EPA/NCSU/RTI (2003), EPA (2006), and RW Beck (2007) for data used to calculate the estimates shown in Table 4.

¹⁸ There is some disagreement regarding the efficiency of the typical landfill gas collection system and of the theoretical limit to landfill gas capture possibilities. For example, see Anderson (2007). This comparison of carbon sequestration versus fugitive methane emissions is based on 75% methane capture efficiency, the default value in EPA's WARM model for calculating GHG emissions from waste management systems.

¹⁹ RW Beck (2007).

The emissions from composting facility operations include a credit for carbon sequestered in soils where the compost is used. The estimate of soil carbon sequestration is from EPA's WARM model, as discussed in EPA (2006). The carbon sequestration credit is larger than the CO₂ emissions from collection and compost facility operations. This accounts for the negative values for composting emissions in the Composting eCO₂ Emissions column of Table 4.

Table 4
Estimated Greenhouse Gas Emissions from Discards Management
(pounds of carbon dioxide emissions per ton collected)

	<i>Disposal eCO₂ Emissions</i>	<i>Recycling eCO₂ Emissions</i>	<i>Composting eCO₂ Emissions</i>
<i>Recycled Materials</i>			
Newspaper	-2,482.4	210.5	
Cardboard	-736.3	210.5	
Mixed Paper	-914.2	210.5	
Glass Containers	88.2	210.5	
PET Plastic Containers	88.2	210.5	
HDPE Plastic Containers	88.2	210.5	
Other Plastic Containers	88.2	210.5	
Plastic Film & Bags	88.2	210.5	
Aluminum Cans	88.2	210.5	
Tin-plated Steel Cans	88.2	210.5	
Ferrous Scrap	88.2	210.5	
<i>Composted Materials</i>			
Yard Debris	-1,083.9		-440.8
Food Scraps	540.9		-440.8
Paper & Cardboard	-914.2		-440.8

3.d. Emissions other than GHGs from discards management

Table 5, Estimated Emissions Other Than GHGs from Discards Management, shows emissions for the other six environmental impact categories from collection, transfer, and landfill disposal of recyclable and compostable materials, as well as from collection and recycling or composting of those materials. Collection, transfer, and recycling or composting facility operations result in the same amount of emissions irrespective of material type. At this point in time available research does not distinguish emissions by material type for collection, transfer, recycling and composting facility operations.²⁰

However, there are emissions associated with use of internal combustion engines to generate electricity from collected landfill gas. Table 5 includes these emissions in the

²⁰ See EPA/NCSU/RTI (2003) for data used to calculate the estimates shown in Table 5.

column Disposal Emissions – Degradables, where degradables include paper, cardboard, yard debris and food scraps. These are the materials that generate landfill gases. The other column for disposal emissions in Table 5 reflects garbage collection, transfer and landfill operations for glass, metals and plastics – i.e., materials that do not degrade in the landfill.

Table 5
Estimated Emissions Other Than GHGs from Discards Management
 (pounds of emissions per ton managed)

<i>Environmental Impact</i>	<i>Indicator Pollutant</i>	<i>Disposal Emissions - Degradables</i>	<i>Disposal Emissions – Non-Degradables</i>	<i>Recycling Emissions</i>	<i>Composting Emissions</i>
Human Health – Particulates	ePM2.5	0.9	0.04	0.4	0.06
Human Health – Toxics	eToluene	455.7	3.3	19.6	48.9
Human Health – Carcinogens	eBenzene	0.00008	0.0001	0.0004	0.0008
Eutrophication	eN	0.1	0.09	0.03	0.2
Acidification	eSO2	3.9	0.2	1.7	0.4
Ecosystems Toxicity	E2,4-D	0.4	0.02	0.05	0.9

3.e. Summary of pollution prevention estimates for recycling and composting

Table 6 summarizes emissions reductions per ton recycled or composted by material type and impact category. The table indicates that aluminum can recycling has the highest environmental benefits across all environmental impact categories, except for carcinogenic impacts on human health where PET plastics recycling provides the top environmental benefit.

Rankings below the top spot vary depending on impact category. For example, mixed paper recycling has the second best climate change benefits, due to the high GHG reductions associated with recycling the high grade papers that are included in mixed paper collected from households. Cardboard is in second place for particulate and ecosystem toxics emissions reductions. Plastic PET containers are in second place for human toxics, eutrophication and acidification emissions reductions.

Among the composted materials shown in Table 6, food scraps provide the greatest climate change emissions reductions benefits. Neither the upstream emissions reduction benefits of composting, nor the non-GHG emissions from discards management for the composted materials, vary by material type. Thus, the emissions reductions for environmental impacts other than climate change are the same for all three composted materials.

Table 6
Estimated Emissions Reductions per Ton Recycled or Composted
 (pounds of emissions reductions per ton recycled or composted)

	Pounds of Emissions Reductions/(Increase) Per Ton Recycled/Composted						
	Climate Change (eCO ₂)	Human Health - Particulates (ePM _{2.5})	Human Health - Toxics (eToluene)	Human Health - Carcinogens (eBenzene)	Eutrophication (eN)	Acidification (eSO ₂)	Ecosystems Toxicity (e2,4-D)
<u>Recycled Materials</u>							
Newspaper	4,937.4	4.9	3,286.0	0.9	-0.2	28.2	7.3
Cardboard	3,823.8	15.0	4,841.5	0.9	0.2	25.2	7.7
Mixed Paper	5,558.2	3.6	902.8	0.0	0.6	18.9	0.9
Glass Containers	675.2	3.8	350.2	0.5	0.1	2.9	1.1
PET Containers	3,452.5	4.3	7,878.8	7.3	1.8	63.8	0.7
HDPE Containers	2,691.6	1.8	2,319.9	2.3	0.7	16.7	0.2
Other Plastic Containers*	2,691.6	1.8	2,319.9	2.3	0.7	16.7	0.2
Plastic Film/Bags*	2,691.6	1.8	2,319.9	2.3	0.7	16.7	0.2
Aluminum Cans	19,830.7	37.5	11,970.2	5.8	2.9	220.4	78.4
Tin Cans	1,975.9	5.7			0.2	3.3	
Other Ferrous	1,975.9	5.7			0.2	3.3	
<u>Composted Materials</u>							
Yard Debris	429.1	1.3	739.1	0.3	5.2	5.8	4.5
Food Scraps	2,053.9	1.3	739.1	0.3	5.2	5.8	4.5
Compostable Paper	598.9	1.3	739.1	0.3	5.2	5.8	4.5

**Emissions for other containers, film and bags are assumed to be the same as for HDPE containers.*

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APPENDIX 3

Detailed Modeling Results

Figure A-1

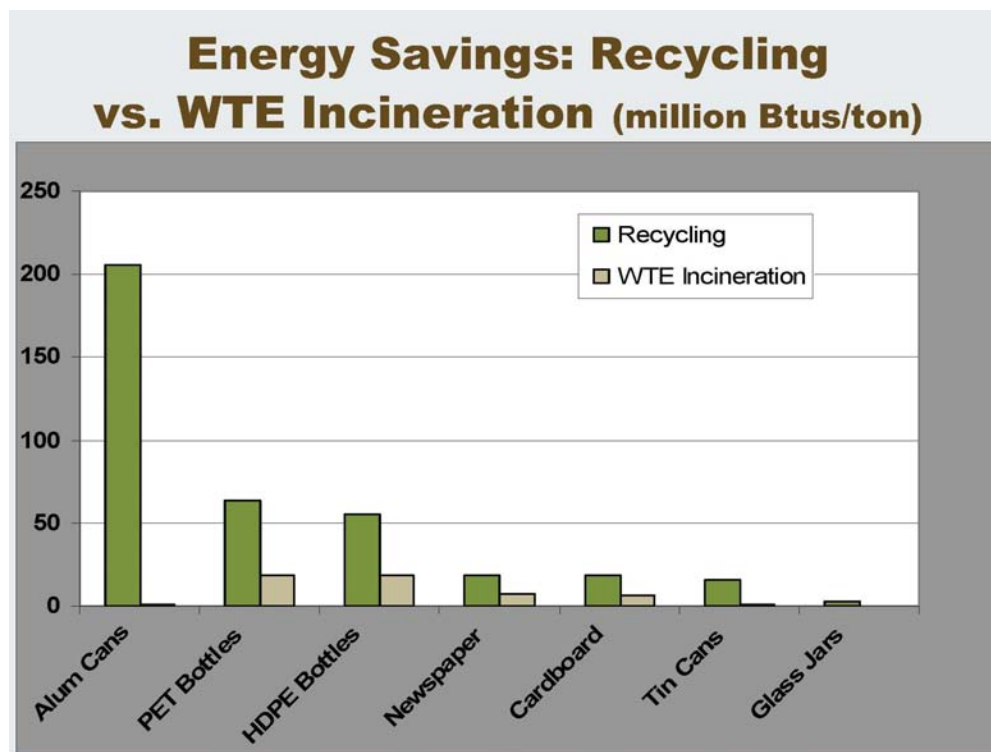


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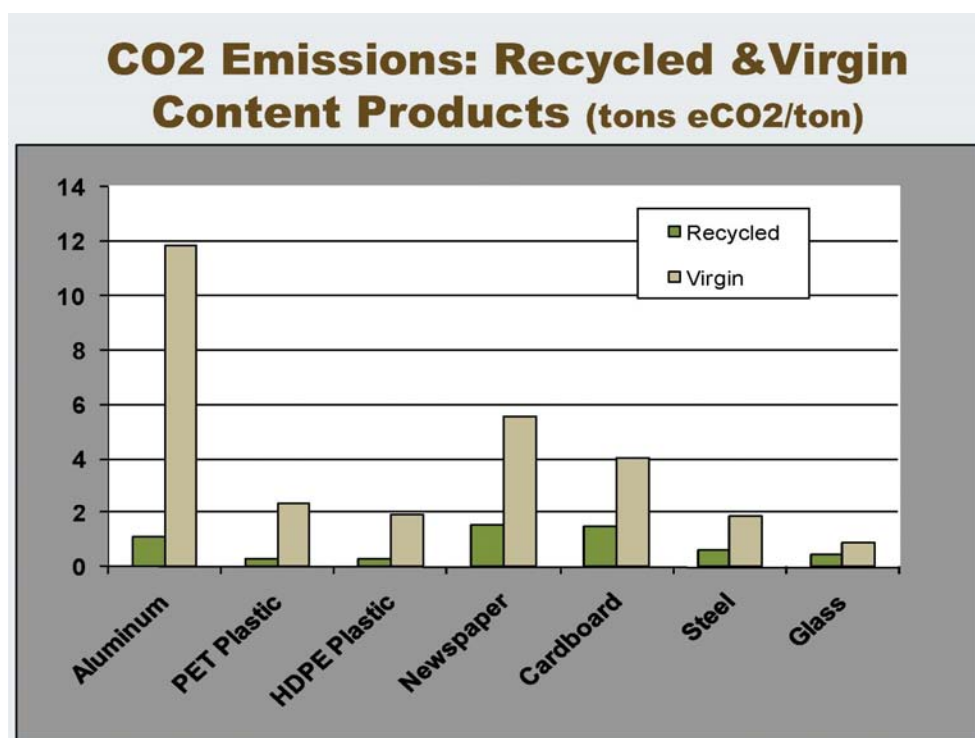


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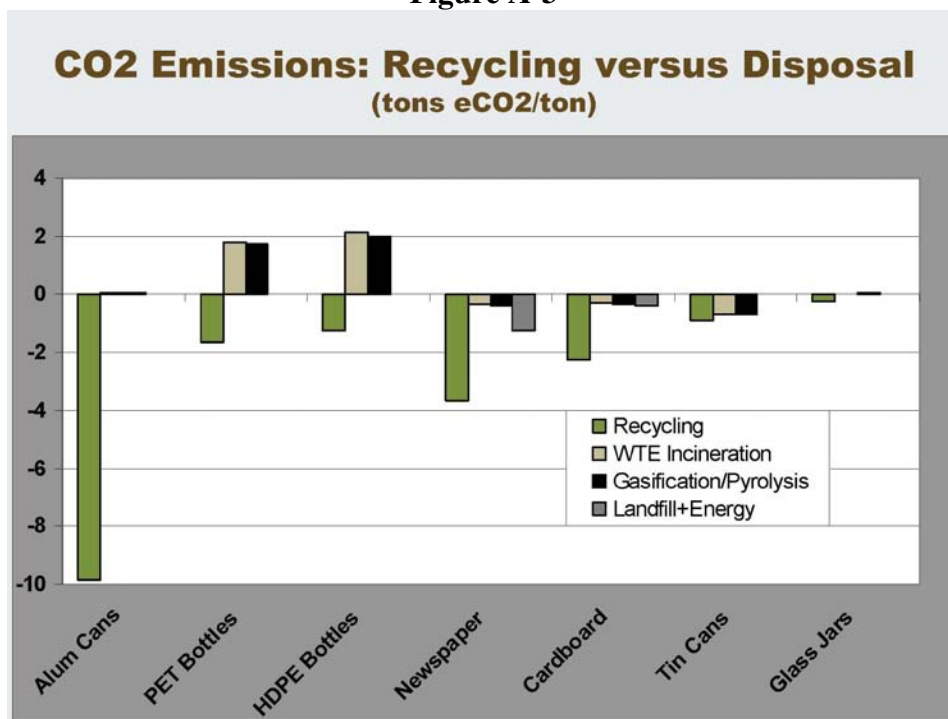


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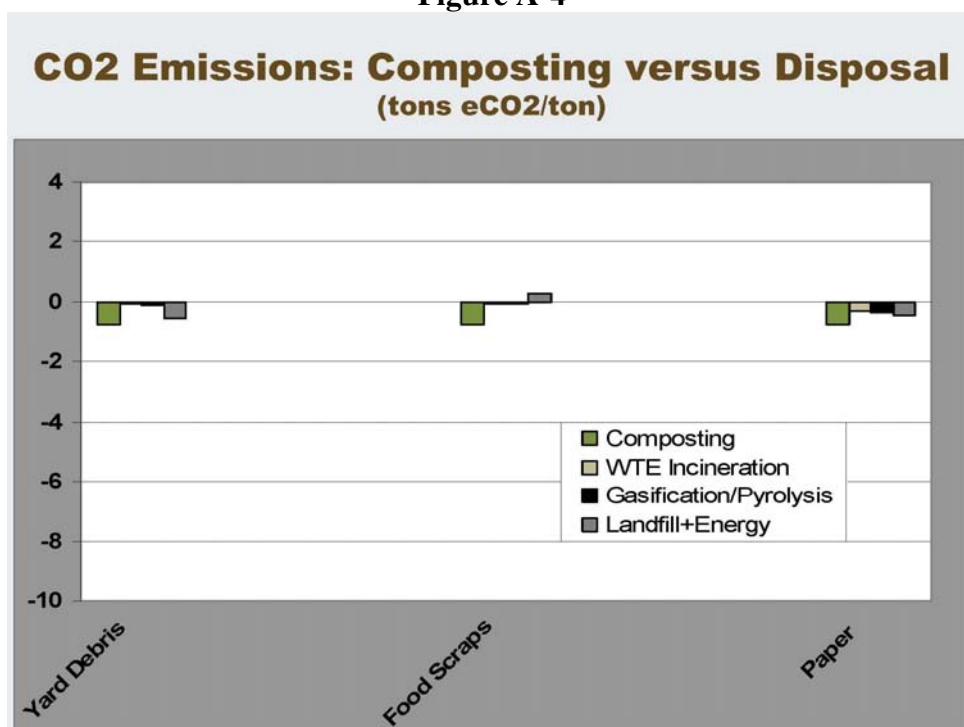


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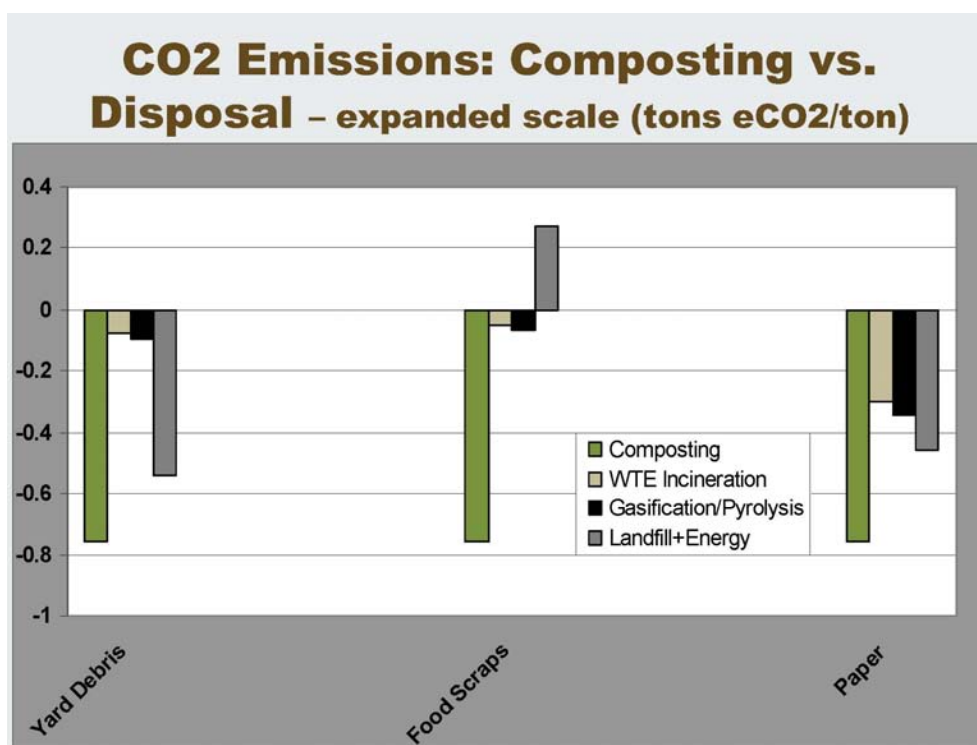


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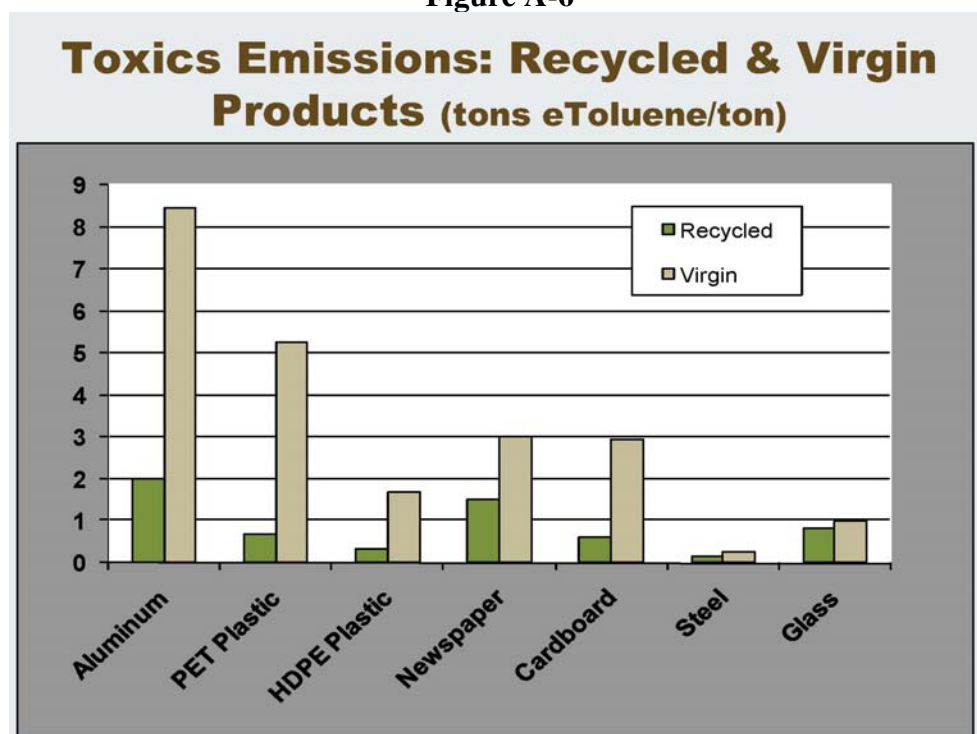


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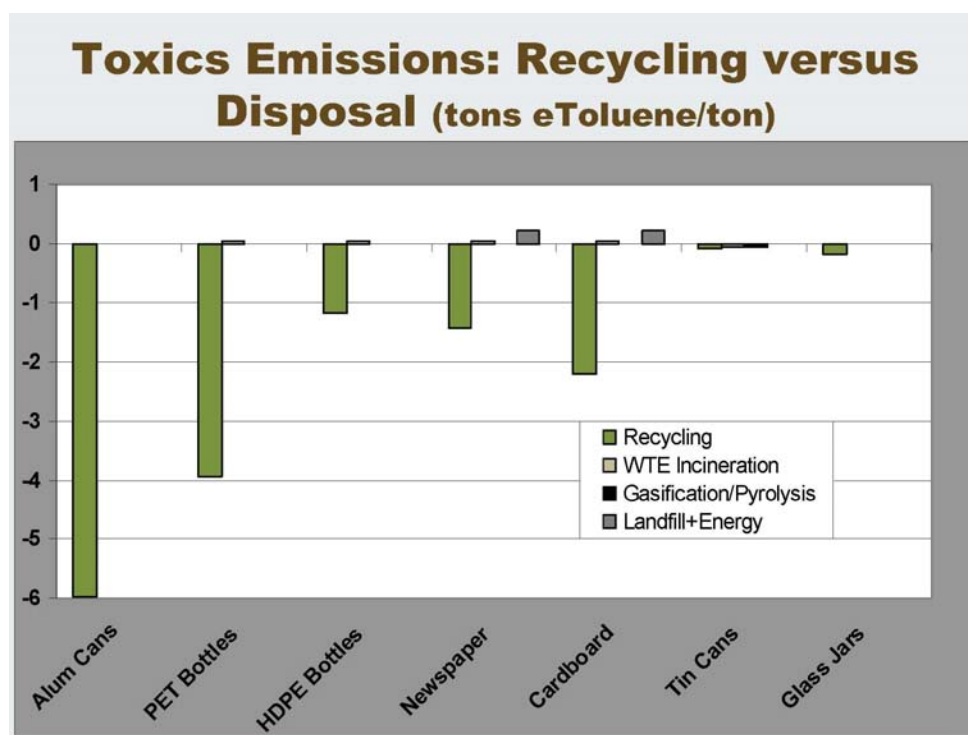


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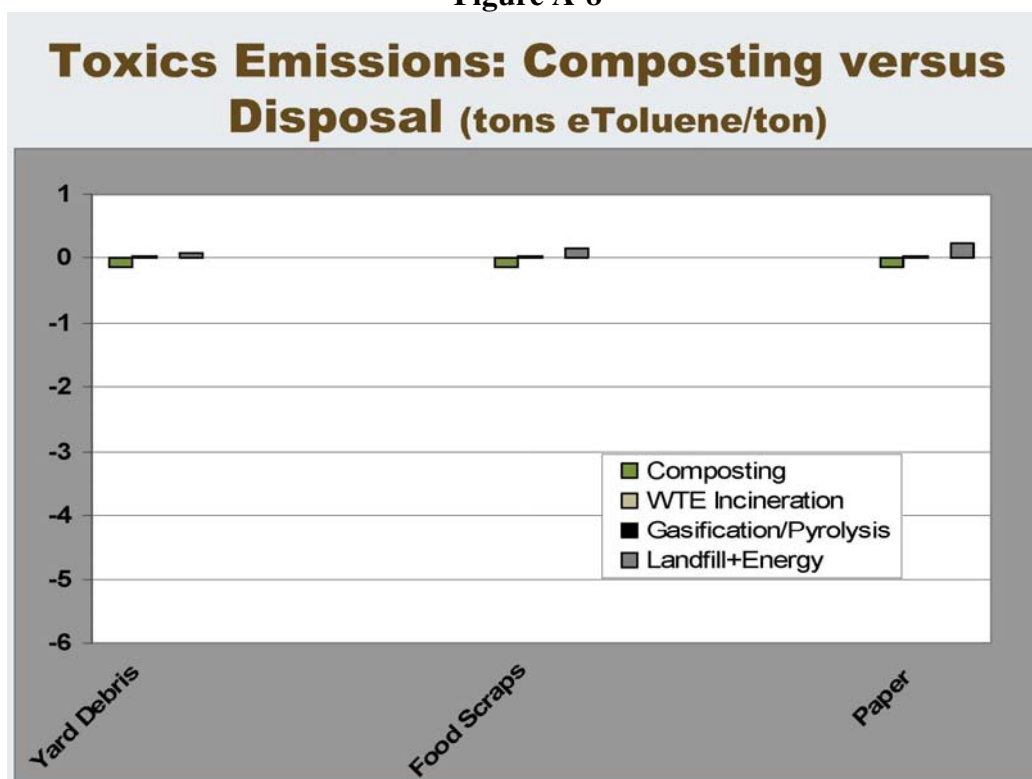


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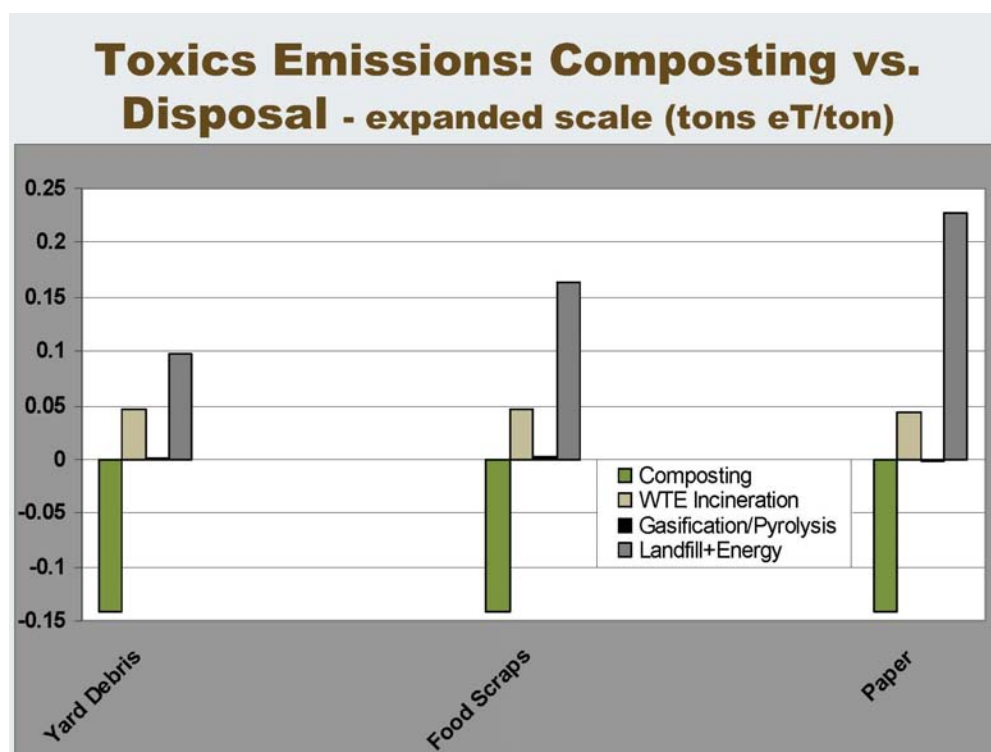


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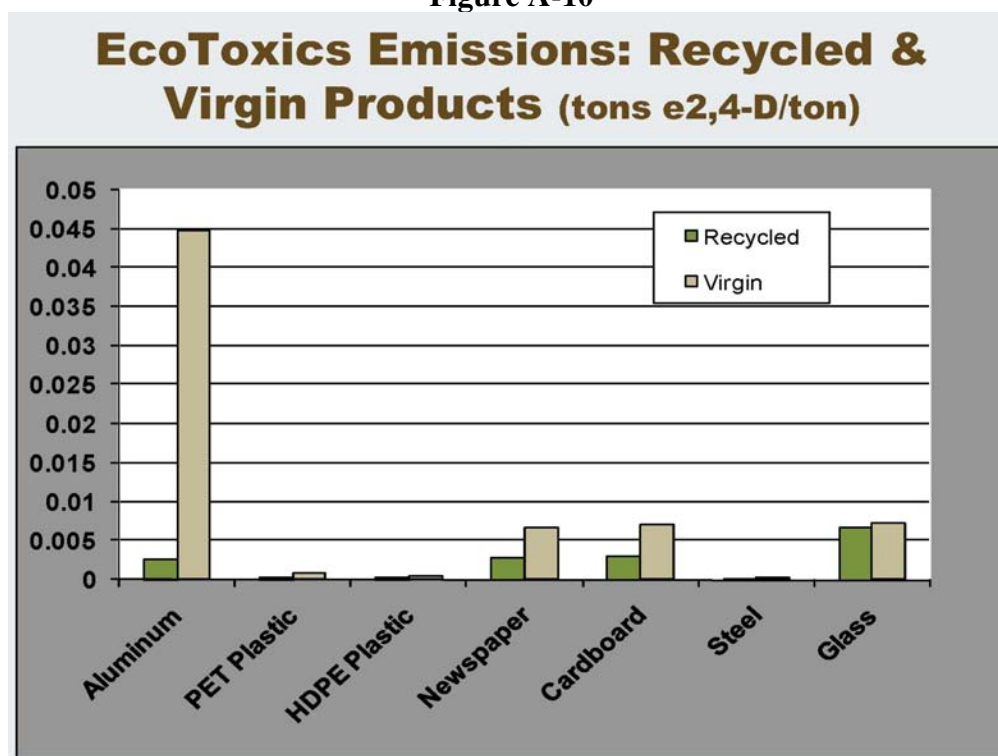


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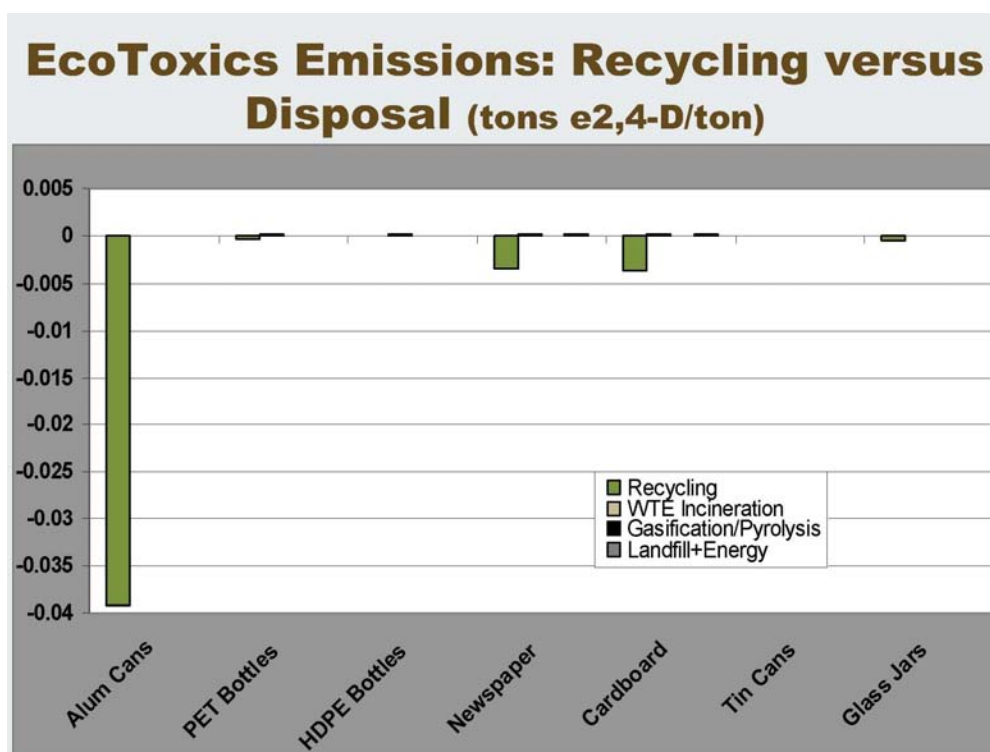


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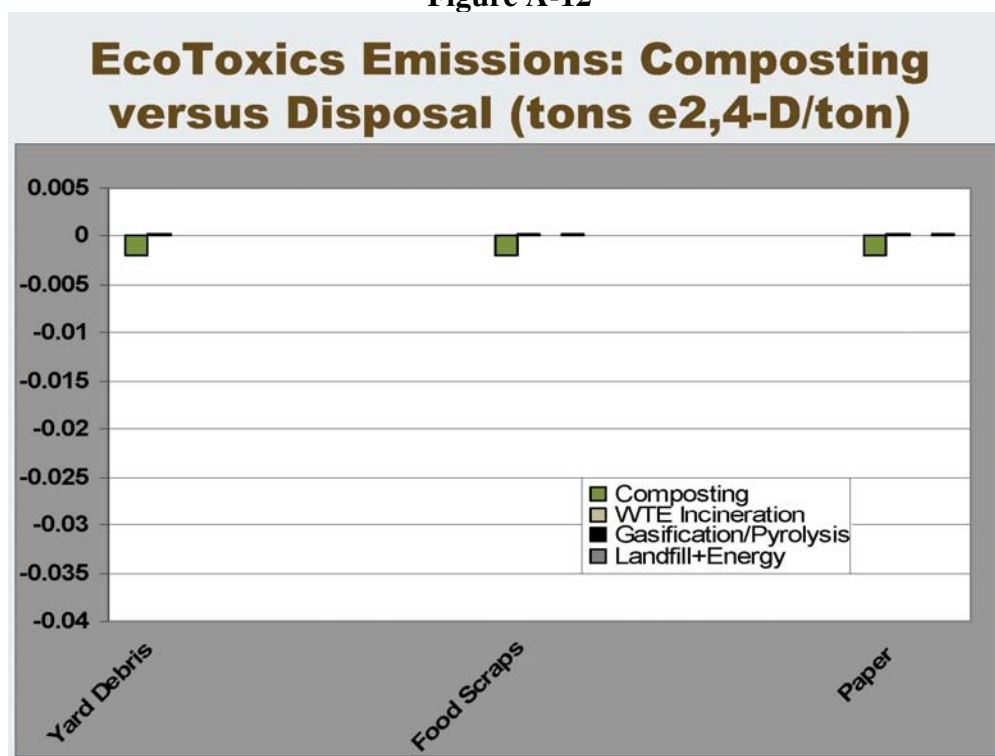


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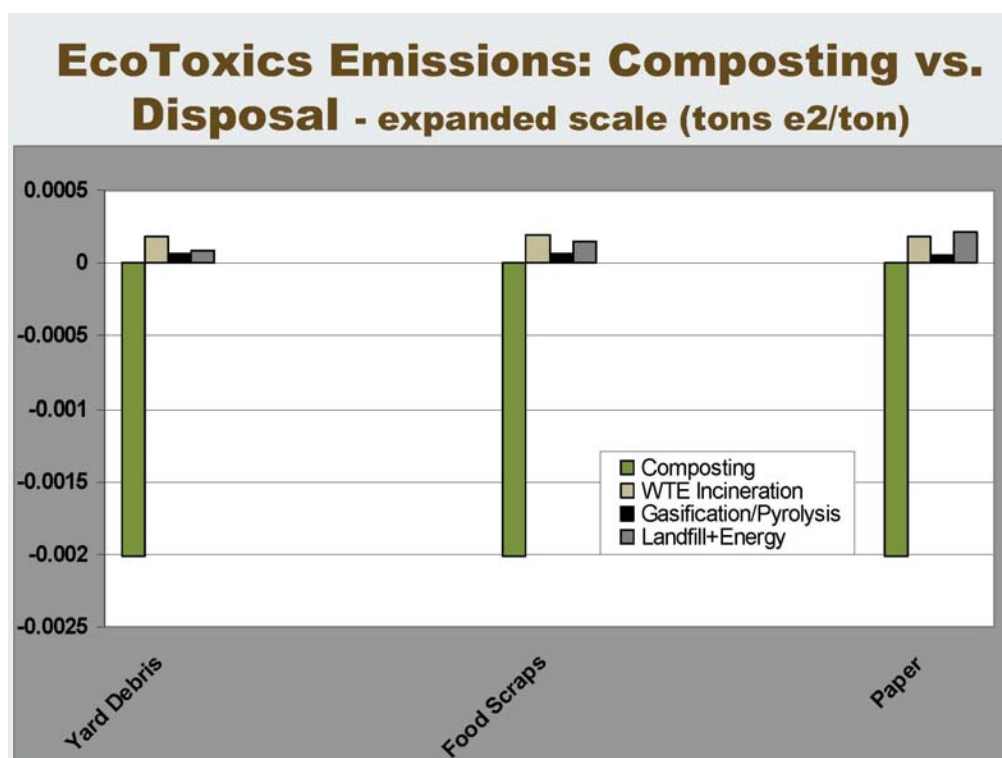


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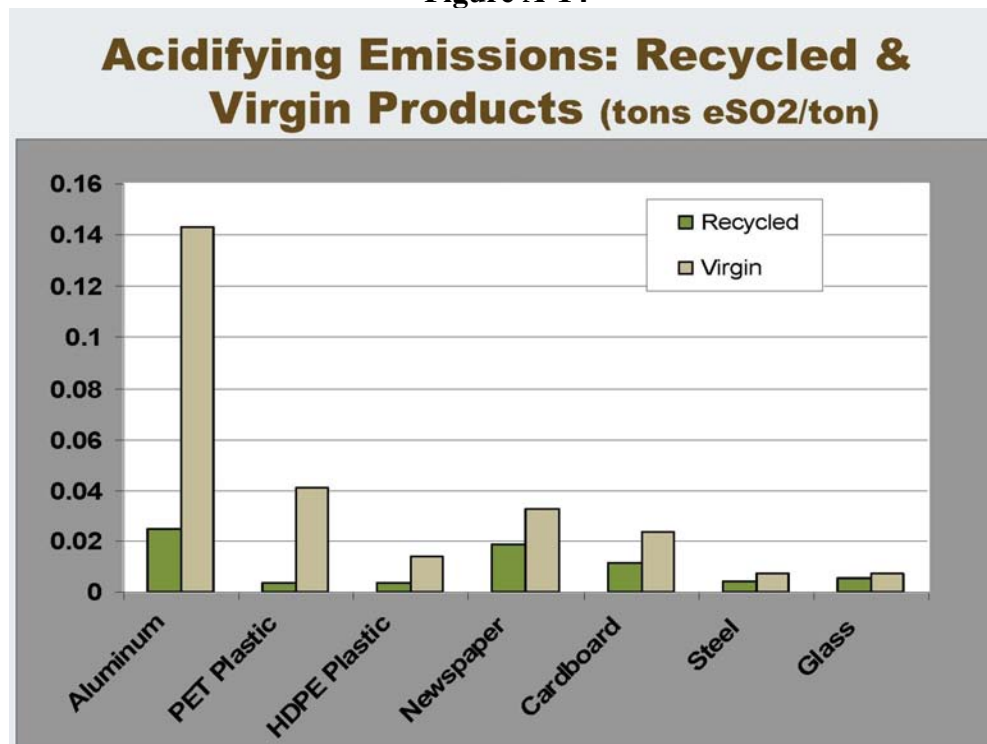


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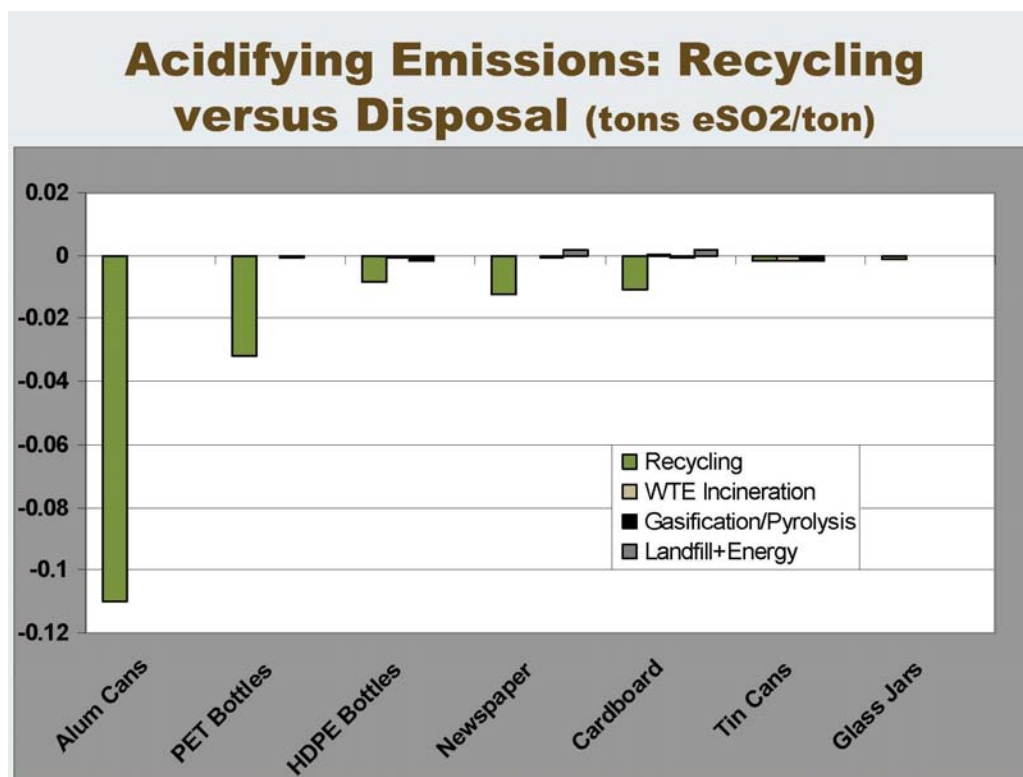


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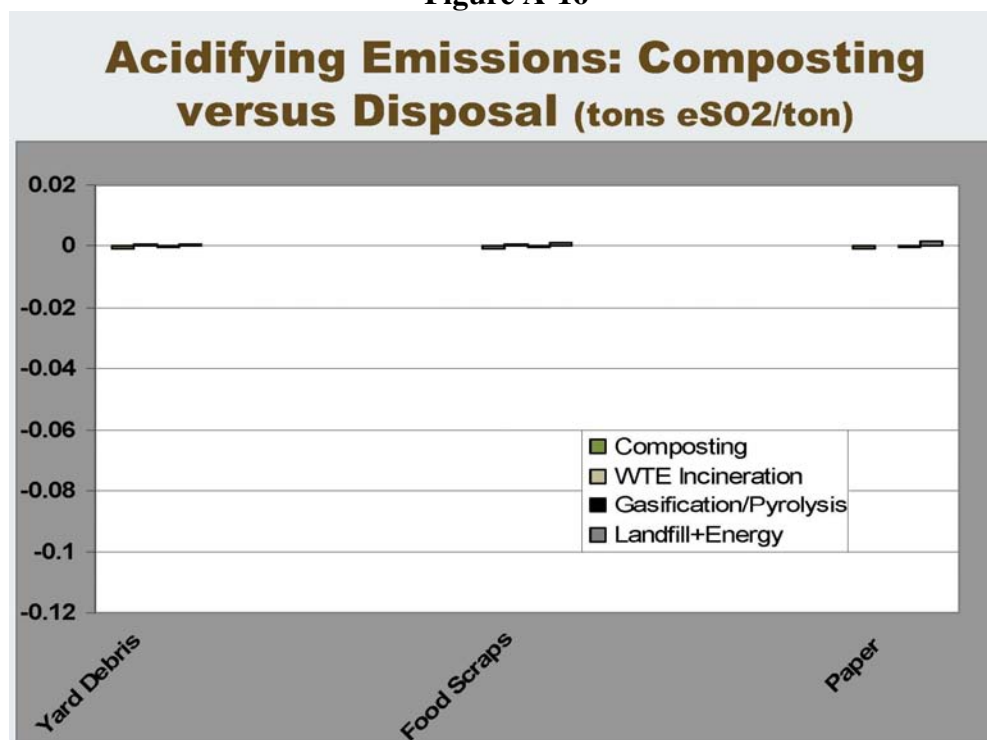


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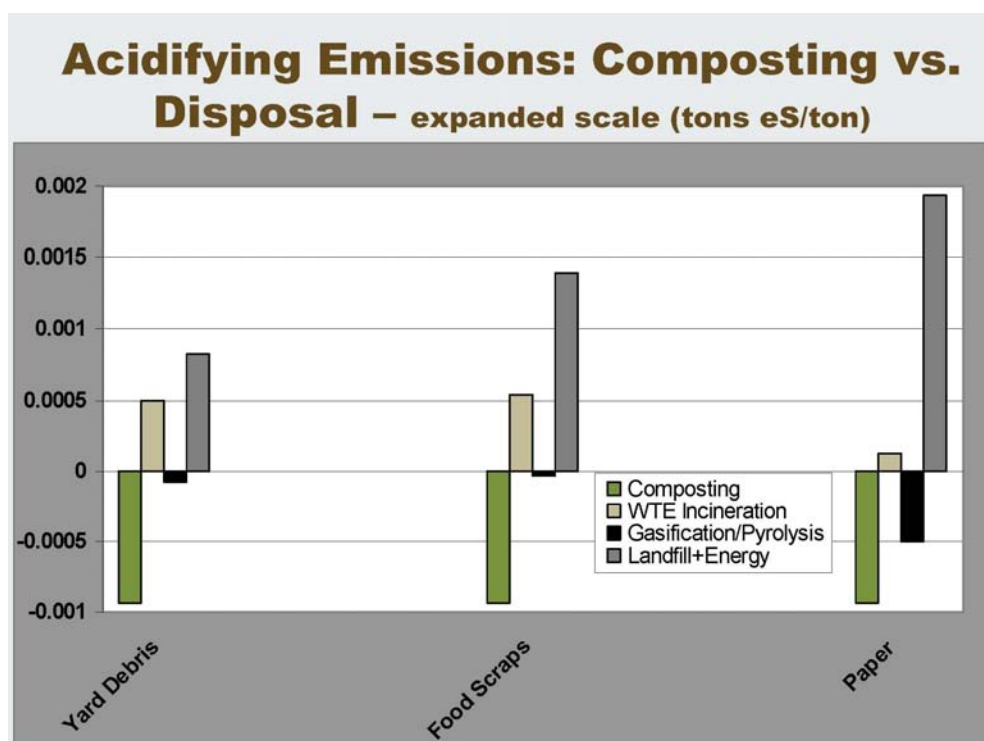


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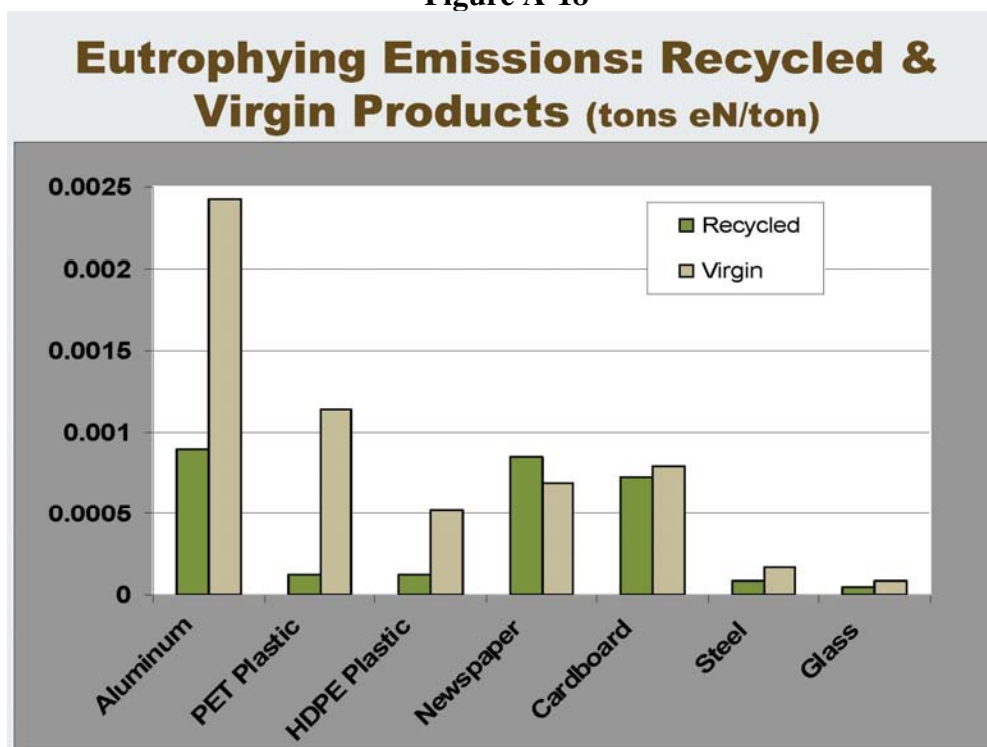


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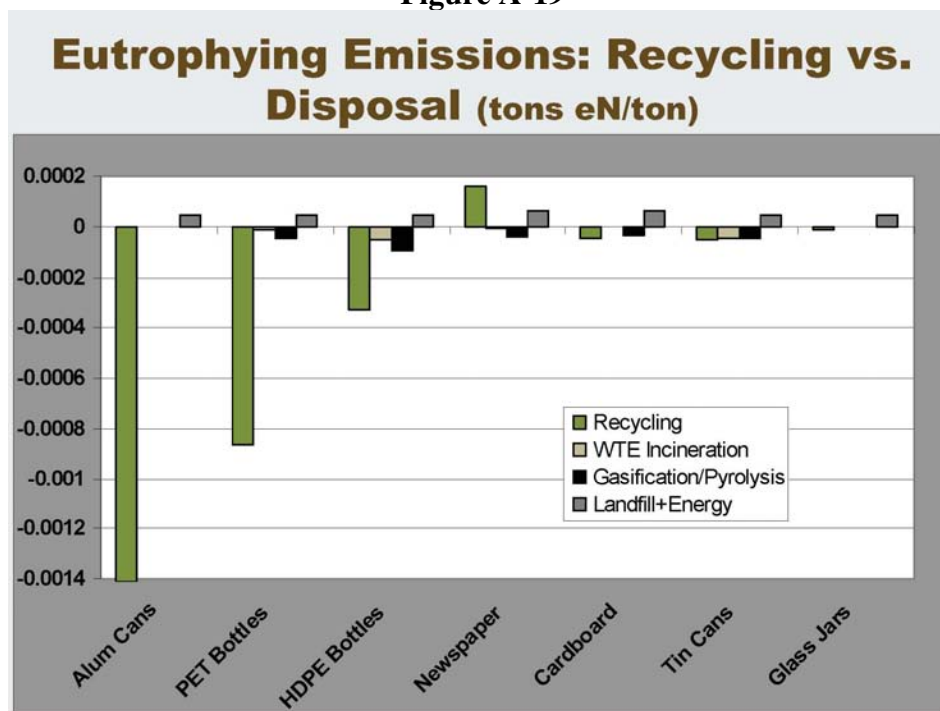


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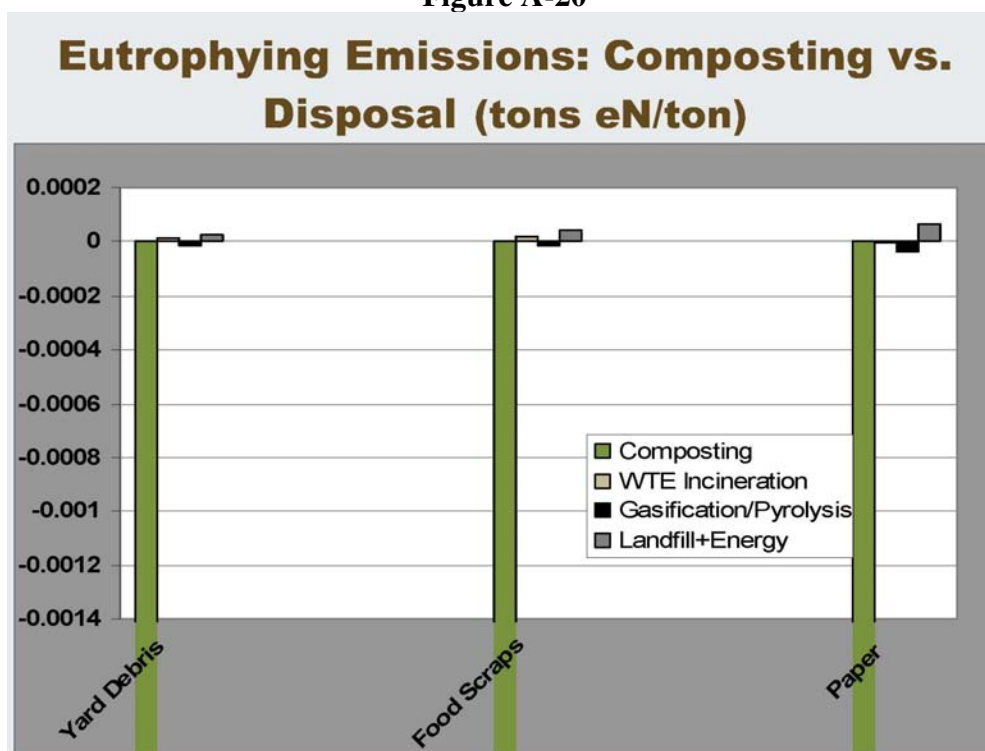


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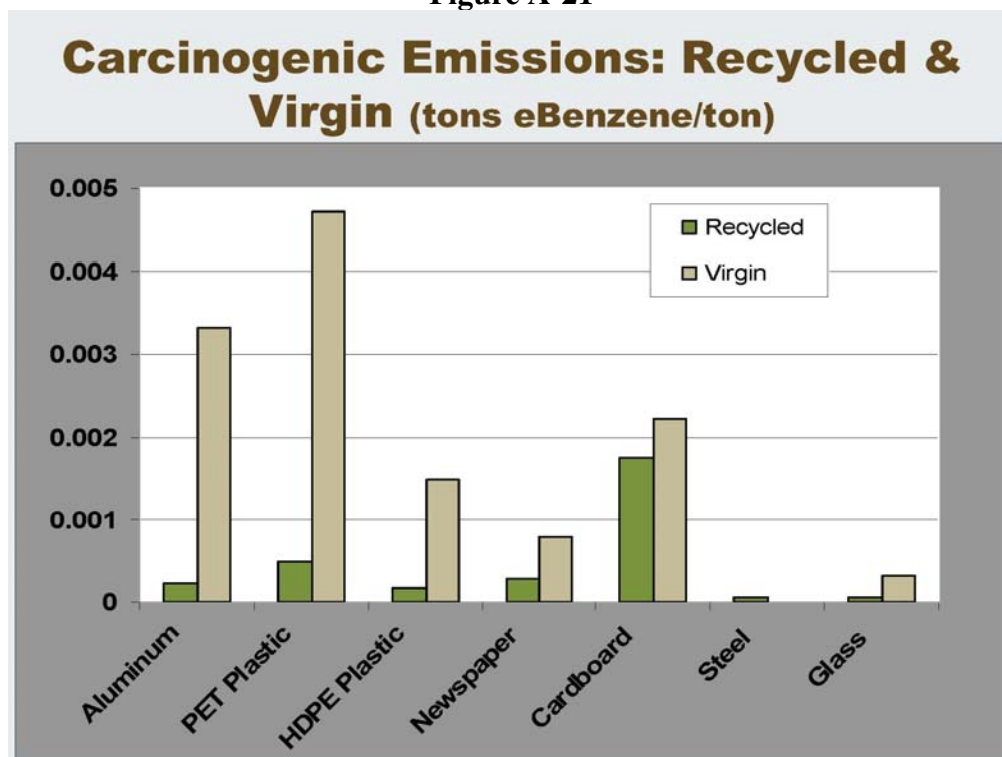


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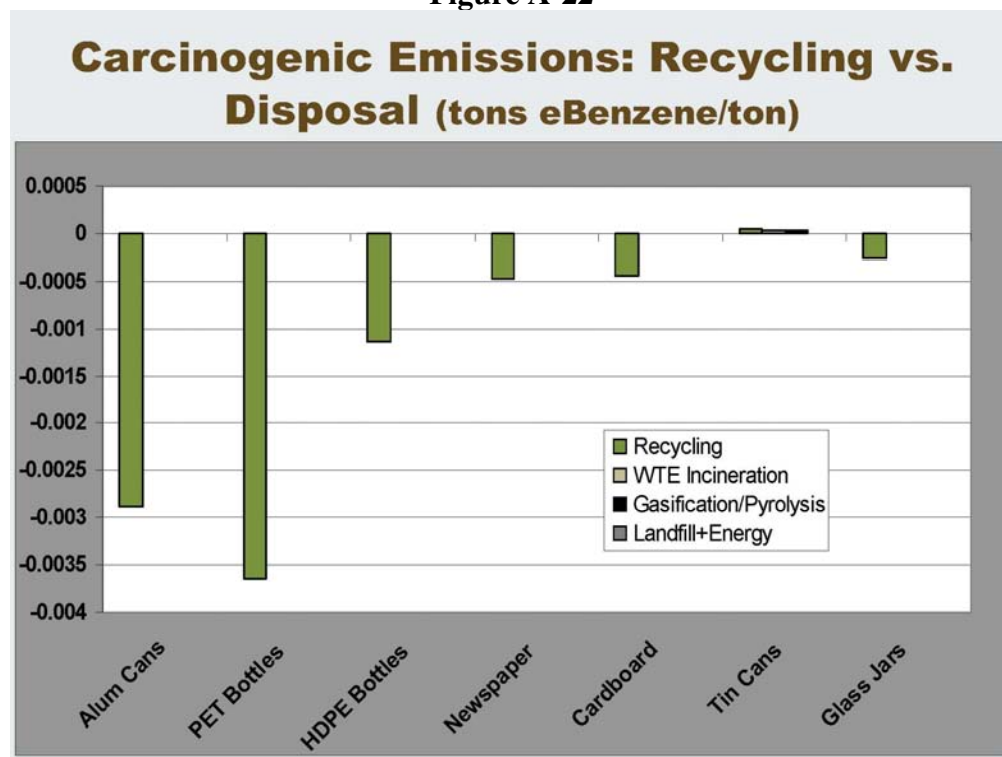


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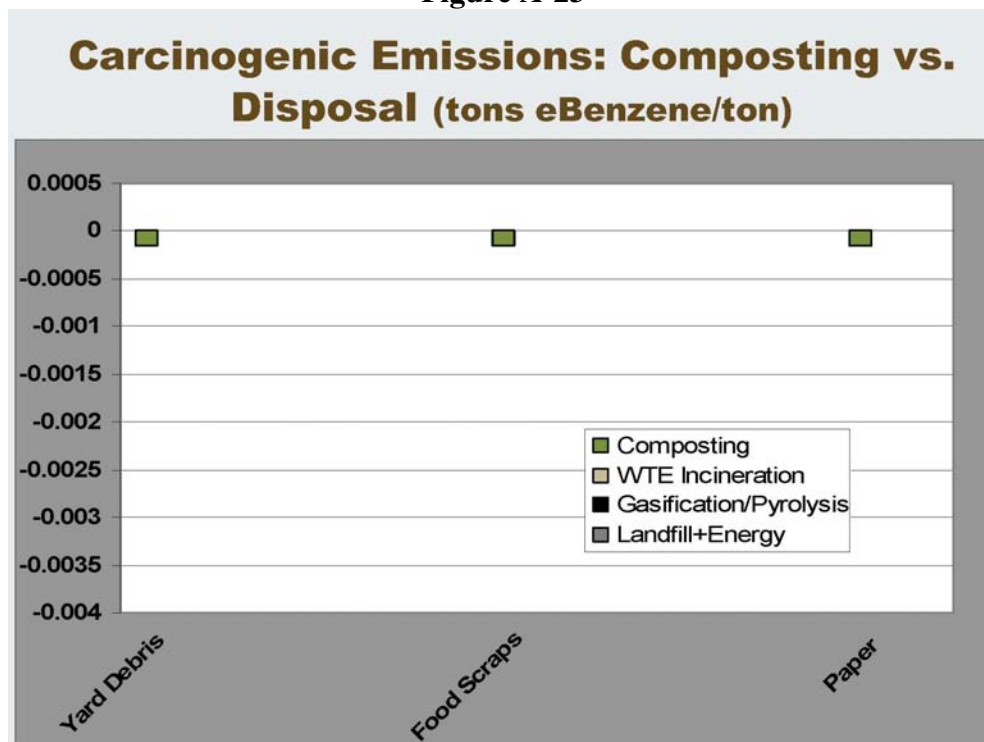


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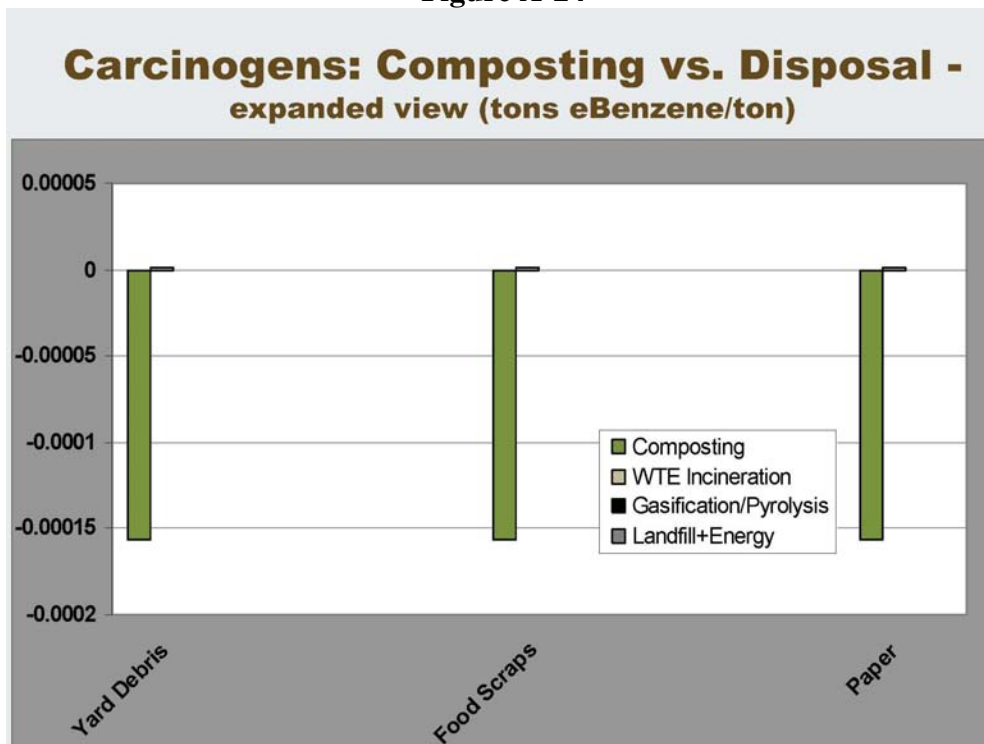


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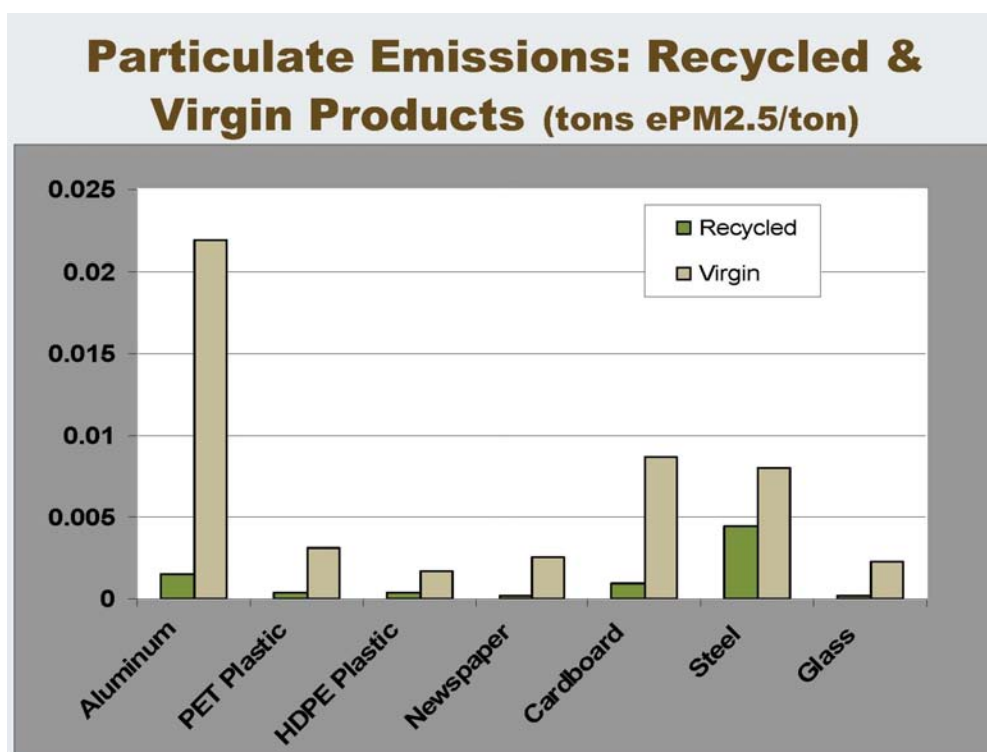


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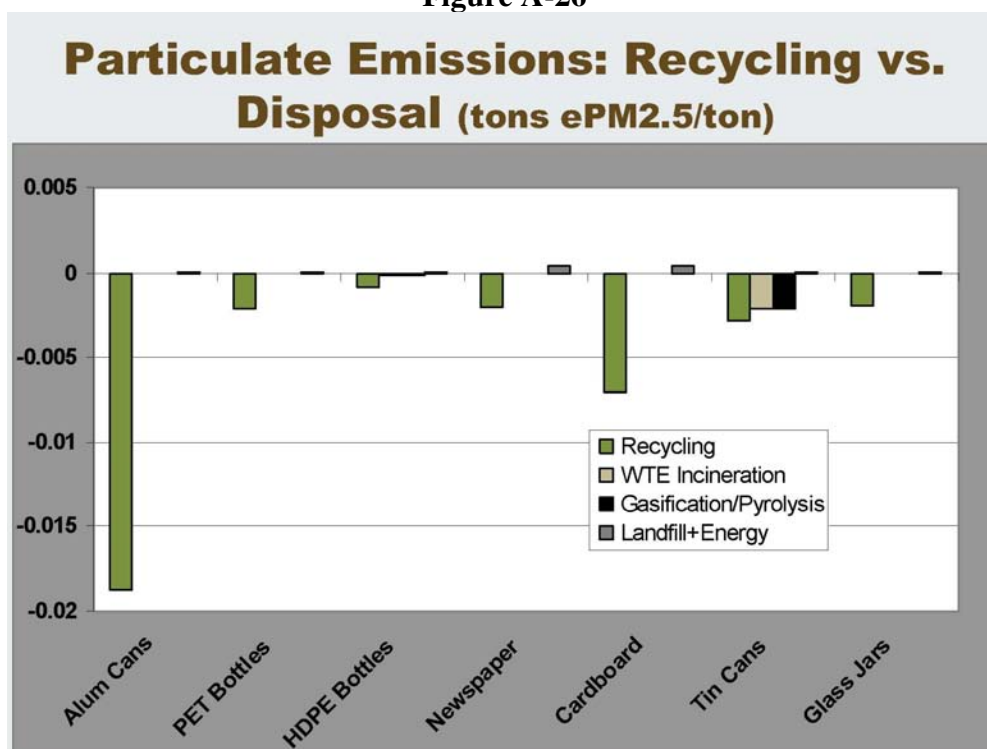


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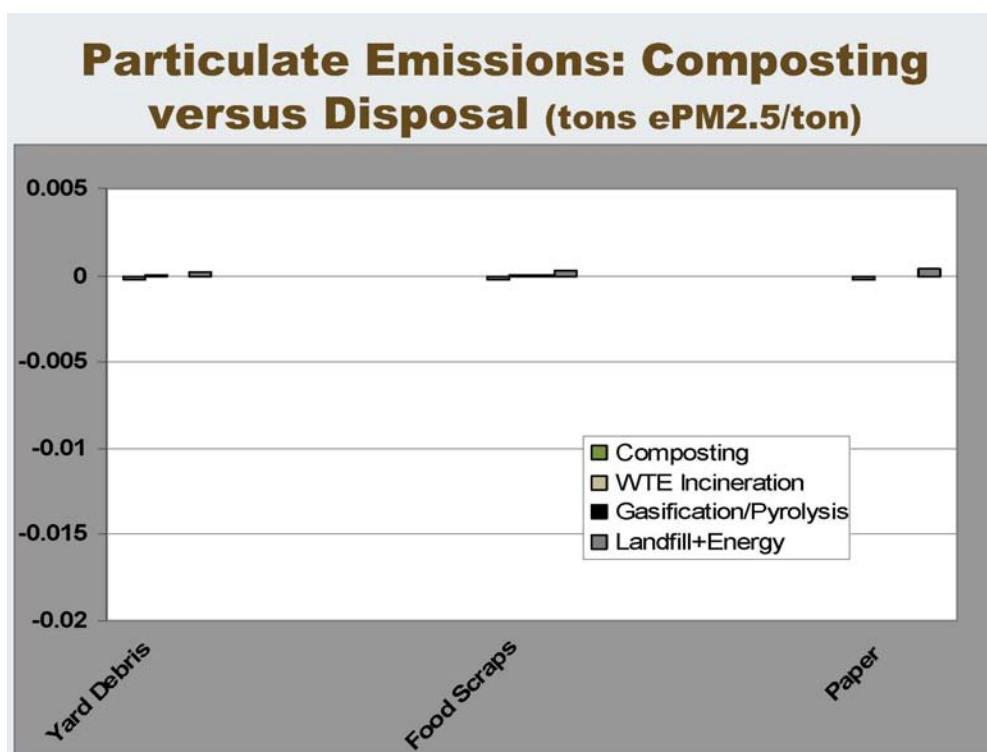


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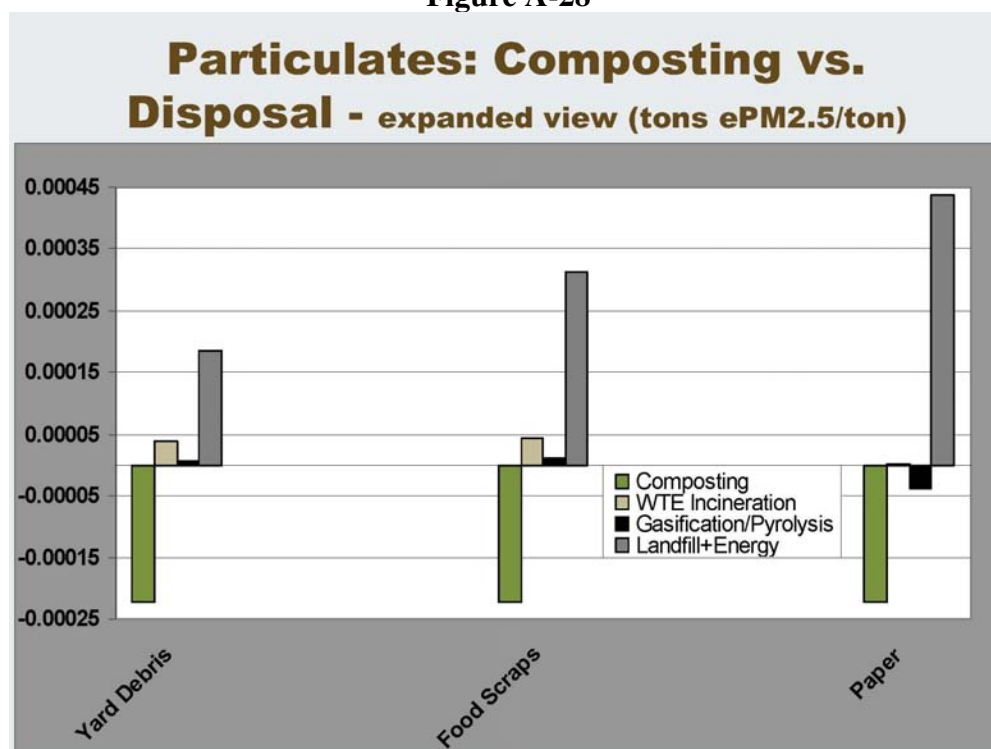


Figure A-29

Value of Pollution Reductions

LCA Impact	Economic Cost (US\$/ton)
Climate Change	\$36 eCO ₂
Human Health - Particulates	10,000 ePM _{2.5}
Human Health - Toxins	118 eToluene
Human Health - Carcinogens	3,030 eBenzene
Ecosystems Toxics	3,280 e2,4D
Acidification	661 eSO ₂
Eutrophication	4 eNitrogen

Figure A-30

Value of Pollution Reductions from Recycling & Composting

Discard Type	Environmental Value (US\$/ton)
Newspapers	\$328-332
Cardboard	424-449
Mixed Paper	156-178
Glass Containers	53-54
PET Plastics	578-646
HDPE Plastics	202-279
Other Plastics	202-279
Aluminum Cans	1,456
Ferrous Cans & Scrap	14-63
Food Scraps	59-97
Yard & Garden Debris	58-67
Compostable Paper	49-71

APPENDIX 4

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